JUNIOR-SENIOR HIGH SCHOOL CLEARING HOUSE

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EDITORIAL

Confusion abounds in current discussion regarding the content and methodology of science teaching. A considerable part of this confusion is due to a failure to keep clear and distinct three concepts, each of which is called "science." These three concepts are: first, scientific attitude; second, scientific method; and, third, science as systematized information.

Scientific Attitude: Science, in this sense, consists of a readiness and ability to reflect, to suspend judgment, to view all factors dispassionately. It is the antithesis of advocacy, defense, and argumentation, on the one hand, and of habit and routine on the other hand. It is a desire for the truth and a grim determination to face all of the facts of the situation and to evaluate carefully every one of them which can be of any conceivable importance to the solution of the problem.

Scientific attitude need not imply, however, the elimination of the self. This would be impossible even if it were desirable. It does require a self-discipline; else, opposition and differences of opinion are so irritating as to interfere with the search for truth. And it does demand a higher selfishness which compels one to realize that immediate victory, if based on "facts" of doubtful validity, may mean ultimate defeat.

Scientific method is a matter of everyday occurrence in the lives of almost all competent persons. At work and at play, as homemakers, students, and citizens, competent persons may generally be distinguished from failures or merely acceptable people by the quality and frequency of their reflective thinking. The motor mechanic faced by a baulky engine who analyzes and reflects, calling upon his experience and his ingenuity, is truly using scientific method.

Scientific method is not monopolized by "scientists." Every housekeeper who in making a cake decides how much baking powder and liquid she should use to replace eggs may reason scientifically. Every motorist whose engine fails him far from a repair shop may adopt a scientific procedure as he seeks to find the cause of the disorder and to make the necessary adjustment so that he can get home. Every baseball pitcher or catcher or coach who sizes up the batter, the base runners, the state of the inning and the game, the morale of both teams, considers the chances that should be taken, and decides on a course of action may use the method of science. Every consumer who decides how much money should be spent and for what, taking into account his resources, the other demands on his purse, the possibilities of investments or savings, may think reflectively and, hence, scientifically.

Science as classified information: Too frequently in the high-school and college

curricula, courses in science are chiefly concerned with the information outcomes of scientists' attitudes and their uses of scientific methods. Success in chemistry, biology, physics, geology, and the rest of the natural-science courses too often depends on "true-false" tested information based on what the textbook has explained or expounded.

Sometimes the teacher or the textbook writer is a scientist in his own right. He really carries on researches and seeks for new solutions of scientific problems or undertakes to verify through the tedious labor of gathering and examining facts the solutions reached by others. More often, however, both teacher and textbook writer are merely learned in the literature of science and in the repetition of artificial laboratory "experiments," the results of which are never in doubt if the laboratory technics have been meticulously executed.

Hence, the science laboratory experiences of most pupils consist in trying to get the results which the textbooks say should follow from the use of certain materials and technics. In other words, youths who know perfectly well that they are not capable of proving the textbook wrong carry on experiments to prove that the textbook is right.

The most beneficial result of such make-believe science is the reënforcement and fuller understanding of the classified information set forth by the textbook. A less desirable outcome, however, is the assumption on the part of students, graduates, teachers, and writers that classified information called "biology" or "chemistry" *is science*. A very undesirable result, too often characterizing men and women who have studied or read "science," is the belief that widely accepted hypotheses are actually established truths. As the old song had it: "If you see it in the book then it must be so."

In the fuller sense of the term, there can obviously be no true science if exact and final answers are obtainable. Scientific attitudes, scientific method, and scientific curiosity can be stimulated and made to function only when there is doubt and uncertainty. The identification of plants or birds or rocks or substances may challenge many youths and adults whose curiosity has been aroused. The explanation of physical, biological, or meteorological phenomena may worry those of scientific temper. To find out how it is possible for a fish to oxygenate its blood may intrigue some youths.

But it is mere play acting to "induce" the "law of the lever" or to "discover" that *Ulmus americana* is *Ulmus americana* or to learn the names of the planets in the name of science—unless such procedures are recognized as mere preliminary practice in technics. Such practice is justified chiefly by its further uses in the solution of questions which bother and irritate the student to the point of a persistent determination to find an adequate answer. To arouse all pupils to such a pitch of eagerness is not easy. Only to the extent that this is accomplished, however, are truly scientific attitudes and methods possible.

Diversified science courses and units are desirable: Not all youths of high-school age are potential scientists. Very few adolescents have achieved sufficient mental maturity to be really scientific.

Many can, however, appreciate the importance of science through participation in collecting, identifying, verifying concrete things—facts and data; they may come to realize how scientists are able to describe, define, and predict variable quantities through their own efforts to do the same things with relatively simple data—seeds, minerals, weather. A considerable number of high-school youths may develop to a degree scientific attitudes if they are permitted to work for relatively long periods on single projects—photography, electric bells, gasoline engines, or animal breeding.

The effort to have all pupils cover al

phases of science, or even to have all members of an elective class perform twenty or thirty experiments leads to an emphasis on information outcomes, and on neatly written and accurately diagramed notebooks. What we actually teach, under such conditions, is that which we reward. Unintentionally, however, we reward not only neatness and accuracy, but dependence on texts and on laboratory manuals and, sometimes, on the measurements and computations of the more capable members of the class who are obliging enough to lend their work to their less energetic classmates.

HIGH SCHOOL AND SCIENCE AND THE MODERN WORLD

Die schönste Jungfrau sitzet
Dort oben wunderbar,
Ihr goldnes Geschmeide blitzet,
Sie kämmt ihr goldnes Haar.

* * *

Den Schiffer im kleinen Schiffe
Ergreift es mit wildem Weh;
Er schaut nicht die Felsenriffe,
Er schaut nur hinauf in die Höh'.

Ich glaube, die Wellen verschlingen
Am Ende Schiffer und Kahn;
Und das hat mit ihrem Singen
Die Lorelei getan.

In the midst of the shoals and overwhelming cross currents of the industrial revolution, we of the high schools keep our gaze fixed as in a sort of hypnotic trance on the charming phantom of "culture." Dazzled by "the arts and sciences"—which we accept as a slogan with no thought of their meaning—we seek to escape from any consciousness of the social forces which hurl our craft hither and yon.

In our schools we teach science—the natural sciences and the social sciences. Science as attitude and science as method and science as information—these are the potential instruments of social salvation. But such potentialities will not become realities under the aegis of "culture."

Science must function, must be constantly applied to the world in which we live and in which we and our children are going to live. Here is the opportunity. "To live in this age, take part in its activities, study the great forces at work, try to estimate their influence, discover the trend and forecast the result; to participate in friendly and intelligent coöperation with men and women everywhere in bringing about a better future—this indeed is an inspiring privilege, a constant joy."

Such a scientific attitude as that implied in the foregoing statement by Dean Withers characterizes the response of intelligent men to this increasingly complicated world. We seek the leadership of the engineer, the statesman, and the philosopher. Each of these men, in his own way, uses the instruments of science. He resolutely combats vague faiths and social inertias; he substitutes therefor tentative hypotheses, suggests plans for increasing the common welfare in the light of such facts as are available. These hypotheses he proceeds to elaborate, to test by the facts in the situation, and to modify before he attempts to apply them. Thus he seeks to attain a better civilization by the use of the very instrumentalities which raise the difficult problems in the modern world. Like the bell in *Macbeth*, science summons the world to heaven or to hell.

"Science," says Bertrand Russell, "is a comparatively new and very explosive force in human affairs, and it is not to be supposed that it has as yet done a hundredth part of its work in transforming society: it has as yet to cope with traditions and beliefs dating in their essence from the beginnings of agriculture. As these traditions and beliefs grow weaker, the influence of science over men's thoughts and feelings will increase. I do not feel by any means certain that the world produced by science will be better than the world in which we live, for, after all, science will have to be

embodied in scientists, in whom love of system may easily lead to repression of much that is good but not easy to organize. But for good or evil the scientific world is pretty sure to come about, and any resistance that we may offer to it is not likely to make it better when it comes."[1]

IF SCIENCE IS TO JUSTIFY ITS PLACE IN THE CURRICULUM, IT MUST BE PLANNED AND TAUGHT AS A "WAY OF LIFE"

In vain do we construct and administer tests of facts and processes. Scientific behavior, scientific enthusiasms, scientific interpretations of material and "spiritual" situations, and scientific efforts to solve questions for which no "right" answers are possible—these are the means and the goals of "science" instruction. Not verbal memories of what books say, but each child's honest efforts to sense irritating conditions, to feel the need, to delimit the problems, to find suggestions, elaborate and evaluate them, and to reach tentative conclusions—these constitute science.

Science has been called "the false Messiah." And narrowly conceived, it is that. Broadly conceived, however, it merges with philosophy on the one hand and with practical purposeful activity on the other. The scientific temper alone can keep the social world oriented and stabilized in its rapid evolution into we know not what.

Such a scientific temper in pupils can be promoted by science teachers only in connection with questions for which each one develops or accepts for himself hypotheses which he believes all obtainable facts to sustain. It can be transferred to the problems of personal and social life only through practice in the natural and social sciences in finding solutions to problems.

And such problem solving must include some elements of preference for one's own solutions. For practice in examining and modifying, even in relinquishing one's preferred solutions when faced by more adequate hypotheses, is necessary if scientific attitudes and methods and information are to contribute to a better world.

"We have had in recent years a brilliant example of the scientific temper of mind in the theory of relativity and its reception by the world. Einstein, a German-Swiss Jew pacifist, was appointed to a research professorship by the German Government in the early days of the war; his predictions were verified by an English expedition which observed the eclipse of 1919 very soon after the armistice. His theory upset the whole theoretical framework of traditional physics; it is almost as damaging to orthodox dynamics as Darwin was to Genesis. Yet physicists everywhere have shown complete readiness to accept his theory as soon as it appeared that the evidence was in its favor. But none of them, least of all Einstein himself, would claim that he has said the last word. He has not built a monument of infallible dogma to stand for all time. There are difficulties he cannot solve; his doctrines will have to be modified in their turn as they have modified Newton's. This critical undogmatic receptiveness is the true attitude of science.

"What would have happened if Einstein had advanced something equally new in the sphere of religion or politics? English people would have found elements of Prussianism in his theory; anti-Semites would have regarded it as a Zionist plot; nationalists in all countries would have found it tainted with lily-livered pacifism, and proclaimed it as a mere dodge for escaping military service. All the old-fashioned professors would have approached Scotland Yard to get the importation of his writing prohibited. Teachers favorable to him would have been dismissed. He, meantime, would have captured the government of some backward country, where it would have become

[1] Bertrand Russell, "How Will Science Change Morals?" *Menorah Journal*, April, 1928.

illegal to teach anything except his doctrine, which would have grown into a mysterious dogma not understood by anybody. Ultimately the truths or falsehood of his doctrine would be decided on the battlefield, without the collection of any fresh evidence for or against it."[2]

P. W. L. C.

[2] Bertrand Russell, *Free Thought and Official Propaganda* (New York: B. W. Huebsch and Company), pp. 16-19.

WHY STUDY SCIENCE?

WATSON DAVIS

EDITOR'S NOTE: *Mr. Davis is an editor, an engineer, a research worker, and since 1923 the managing editor and secretary of Science Service Inc., Washington, D. C. He editorially directs ten newspaper syndicate services reaching over twelve million readers. His science articles aggregate three volumes a year. He is the author of* The Story of Copper, *Century Company* (1924). *Mr. Davis has been actively associated with government research, particularly in the field of concrete manufacture. He has invented several improvements of processes. His wide experience peculiarly fits him to contribute the introductory article of this science issue. The* JUNIOR-SENIOR HIGH SCHOOL CLEARING HOUSE *is proud to welcome him among its contributors.*

J. M. G.

Progressive communities are proud of their expensive, modern, and useful school buildings and equipment. Tax-paying parents gladly afford these facilities for their maturing children. The fine architecture of the modern school is a visible guarantee to the public that the younger generation is being given a better deal in life than the generation now running the world.

About the studies pursued in these fine buildings there is less boasting, less thought, and less pride. The parents have great difficulty in seeing inside the classroom. And adequate buildings give no assurance of adequate curricula.

The same school trustees who would be the first to protest if the architect suggested stoves for heating, oil lamps for lighting, and wood as the constructional material, raise no protest when courses of study are so arranged that students can be pronounced "educated" without gaining the slightest insight into the modern scientific methods and facts that have revolutionized the civilization in which they must live their lives and gain their livelihood.

That high-school students in many instances can complete their years of study without once attending a class in physical or biological science is evidence of the incompleted metamorphosis of our educational methods made necessary by the changes in the civilization in which we live. In the days of the renaissance in Europe and in America's own pioneer days when arts and crafts were home or guild industries, technology and science were learned in the home or in the closely knit community. Youths, exceptional in ability and opportunity, in Europe went to tutors or school to learn Latin and Greek in order to read classics, or, in America, to learn the three R's in order that they might take a more influential part in the developing of colonial life. Except for those who were to enter the ministry or the teaching profession, education in those days was largely "cultural" rather than practical.

Was it Francis Bacon or Leonardo da Vinci who boasted, "I am the last man to take all knowledge as my province"? With increased knowledge, with the accumulation

of intellectual achievements of past generations contained in our intellectual heredity and libraries, the feeling has grown that no one man can know all things. Strictly speaking, this is manifestly true. Nevertheless, the need for broad fundamental knowledge of all things is more urgent for the common man today than it was even fifty years ago. Thanks to the labors of his predecessors, the schoolboy of today can and should have more accumulated wisdom and knowledge at his fingertips than the wisest sage of the Middle Ages. What is far more important, he should know and be able to utilize the scientific methods of thinking and doing. Thus equipped, he can recapitulate the experience of his predecessors and rediscover for himself facts which he has not yet acquired or which are buried in the accumulation of knowledge that we have today. Healthy skepticism and ability to discover facts for oneself are far more important than a large stack of memorized facts and theory.

From a purely utilitarian standpoint a knowledge of science is a necessity to every individual in this scientific age. The musician will play more expertly if he has some conception and knowledge of the physics of the music. Bricklayers, carpenters, and painters exercise a practical advantage over their coworkers if they understand the scientific principles of the labors they are performing. The clergyman, in rendering spiritual assistance to his parishioners, must utilize the latest discoveries of psychology. And information on the effects of light and color will allow him to make his services more impressive, if that is the desire of his congregation. The lawyer grounded in science will often win a case or prevent a lawsuit through the use of his knowledge. The cook, working with complex chemical substances, will please the palate if she adds to her experience and recipes the known principles of chemistry. The housewife, who controls the intricate industry which is the home, must be, among her other functions, a building engineer capable of servicing the radio, the mechanical refrigerator, the electric lights, the gas system, the oil heater, the water-supply system, the vacuum cleaner, and a variety of other mechanical apparatus that have become indispensable to her. Every one needs to know about the mechanism and frailties of his own body in order that it may be kept running without undue recourse to the medical profession.

So it is that science needs to be studied not alone to make scientists, but to make laymen. Dr. Edwin E. Slosson, the late director of Science Service, in the work of which we happily coöperated for nearly a decade, put this point as follows:

"The object of the effort to spread a knowledge of science among as many people as possible is not with the view of converting them into scientists. That is impossible. A scientist is not one who reads science or studies science. A scientist is a man who makes science. This is a mere matter of language. A musician is a man who makes music. A novelist is a man who makes novels. A painter is a man who makes pictures. A contortionist is a man who makes contortions. So a scientist is a man who is engaged in original research who is converting the crude phenomena of nature into systematic and logical form."

Science has often been charged with being grossly material in its service to the world. It can only answer "guilty" to the charge that it has supplied our life today with a multitude of comforts and benefits undreamed of by our forbears. But that science caters only to the physical environment of man and ignores the intellectual and cultural side of his development, is untrue. Science provides a code of conduct far more inspirational and of much greater potentiality for human progress than philosophies and religions of yesteryears. Built upon the foundation of what we know and

what we can demonstrate, reasoning from the similarity of nature and allowing the experience of the past to guide the future, science as a guide for intellectual and moral conduct maintains the fluidity of formulation that is the essence of any progress. Unlike older philosophies that conceive creatures existing in accordance with the whims of the Creator or explain the world as the result of understandable causes, science builds logically and deductively from the the unknown and through its aid man slowly explores unfamiliar heights.

If Latinists and other exponents of the old-fashioned classical education contend that advocates of science in the curriculum are destroyers of culture, their protests may be bounced back to them with the observation that languages, English among them, along with the stenography, typewriting, woodworking, and mechanical drafting of specialized high schools, are handmaiden studies. With the exception of those who teach, only translators derive their primary livelihood from the study of languages. I do not mean to minimize the desirability of learning languages. But ability to speak and write a foreign living tongue, the ability to speak and write English correctly are in the same educational class with proficiency in automobile driving and expertness in swimming. They are didactic subjects, in which, like the law, precedent controls. Originality and innovation do not find their reward if they are exercised in an attempt to improve the present good usage of English, French, or German. The entrenched position of Latin in secondary education is a survival of the days when one needed a reading knowledge of Latin in order to tap the important written records of organized knowledge.

In addition to languages and English, other subjects among the present "required" studies in secondary schools today fall within the category of handmaiden, servant, or helper subjects. In history it is dangerous and futile to question the date of the discovery of America. In mathematics the accuracy of the multiplication table is hardly open to question, and in many sociology classes it is indeed dangerous to suggest improvements upon existing social orders. High-school physiology often emphasizes the dangers of alcohol and tobacco but seldom suggests or offers experimental proofs. As often taught, these courses are an appeal to the memory rather than to the reason, the teacher talks as one with authority rather than one who is aiding the students to find the truth.

The same criticism may be leveled at some existing courses in science. To require students to learn by heart the three laws of motion without understanding the physical basis and circumstances of their formulation is no more laudable than the enforced memorizing of a series of historical dates. If the danger of teaching science as a theology is averted, there still remains the possibility that each teacher of some one scientific course will fail to see and to pass on to his pupils the interrelation of his science and all the other sciences. Pigeonholes in old-fashioned rolled-top desks have gone out of date but they still exist in curricula. The situation is not wholly the creation of the secondary-school science teacher. Scientists themselves are not always alive to the "associations" between biology, chemistry, physics, and even astronomy. Biochemistry, biophysics, and astrophysics are relatively recent breeds of science. Instruction in science cannot be expected to be more advanced in its concepts and its organizations than research itself.

The introduction of courses in general science in junior high schools or the early years of senior high schools is evidence of recognition of the unity of science. It is reminiscent of the days when, as Oliver Wendell Holmes puts it, professors occupied settees rather than chairs. The general-science course is the modern equivalent

of the lectures in natural philosophy which college presidents of a century ago were in the habit of giving to their seniors with the purpose of welding together the divergent knowledge they had acquired during their college years. The modern method is more logical and beneficial, provided the teacher entrusted with the difficult task of inspiring and explaining the unified scientific knowledge to immature minds is equal to his task.

Those who rightfully aspire to place science on the lists of required subjects for junior and senior high schools should be even more ambitious and urge that scientific fundamentals be taught from the very day that the child enters the school door for the first time. Those early years when the youthful mind seems a perpetual question mark engaged in insatiable voyages of discovery present opportunities for science instruction that will never come again. Little children should be introduced to the stars: they may never have a chance to contemplate the heavens once they are plunged into modern economic life. The ingenuity and beauty of nature shown in the birds, animals, flowers, trees, and insects of backyard, fields, and forest are most wonderful and impressive to us when we are young. Such opportunities for the acquisition of true culture can be intermingled with the lessons in reading, writing, and arithmetic.

Curriculum makers will sigh sadly if it is suggested that areas of science now untouched in most schools should be injected into secondary education. It may seem strange that newspaper readers are more interested in archaeology and astronomy than they are in more practical sciences. I doubt whether their interest in these two sciences is in any way correlated with the fact that they are not taught in high school. In psychology, the science of human behavior and thought, the general public, as measured by what the newspapers like to print, is also greatly interested. At present these subjects can best be covered, perhaps, in the general science courses, but it is to be expected that they will be bidding for their semesters and their years in the schools of future years.

With the inevitable extension of science into all the years of education, primary and secondary, careful planning will be necessary to prevent the monotonous repetition that sometimes occurs. I remember that during my primary education history began in nearly every grade with the discovery of America and seldom progressed further than the Declaration of Independence.

Science teachers will need to call in as their allies the other members of the teaching staff. How can a history teacher hope to explain the developments of the past hundreds of years without discussing the scientific renaissance in which we are immersed? The Latin teacher might well turn the attention of his advance students towards the classics of science written in medieval Latin. Can it be claimed that Cicero's orations were any more important than Agricola's *De Re Metallica* so expertly translated by Mr. and Mrs. Herbert Hoover? There may even be a demand for the teaching of Arabic when it is realized that it was the language of science in Moslem lands when Europe had its dark ages. The science faculty can ask the coöperation of English teachers in incorporating into the study of current events the latest developments in science as they are reported in the newspapers and magazines of today.

Whether the torch of civilization will burn brightly is determined in a large measure by the educational opportunities of the constant stream of adolescents passing through our secondary schools. With keen insight a Philadelphia neurologist and professor recently declared that the best trained educators should be working in high schools, guiding boys and girls through the important stage of adolescence rather than teaching college students who are not nearly so teachable.

The 'teen age sees the births of great philosophies and the beginnings of great discoveries. It is the time of life when great men and criminals alike are made. Minds develop along with adolescent bodies.

Galileo was but seventeen years of age when, peeking around his hand during prayers in the cathedral, he discovered the principle of the pendulum by counting the swings of the cathedral's chandelier. Perkin at eighteen, when mussing around in an improvised laboratory during vacation, discovered mauve because he had no pure chemicals. Humphry Davy, who used chemicals as his toys at the age of fourteen, laid in those useful years the foundation of his later discoveries. Newton at twenty-one, when his college was closed on account of the plague, did his pioneer work on the theory of gravitation. Edison with his chemicals in a railroad car was well launched on his inventive career.

Who can ignore the similarity between these historic careers and the intense activity of modern schoolboys who build model airplanes, talk to the ends of the earth with their own radio sets, and tinker with $25 automobiles?

I am not unmindful that only the exceptional few among school children of today will have the ability and opportunity to follow in the footsteps of the great pioneers of science. But properly cultivated and developed through science teaching the curiosity and innate interest of the average pupil will give him that minimum of scientific spirit neecssary for success in this modern age. Today all must be vaccinated against superstition, the false doctrine of ignorance. All should be wiser than the Greeks who thought that the earth, air, fire, and water were elements. Tomorrow's civilization may be found in the schoolroom of today.

A THREE-YEAR SCIENCE SEQUENCE AS A FUNDAMENTAL NEED IN THE JUNIOR HIGH SCHOOL

GEORGE C. WOOD

EDITOR'S NOTE: *Dr. Wood is head of the department of biology and general science at the James Monroe High School, New York City. For ten years he has been actively associated with the development of science syllabi for New York City and New York State. He has been chairman of three science committees. He is a leader in the movement to create a science sequence through elementary and secondary schools. In his letter transmitting the following article Dr. Wood writes—"We actually live and move and have our being in this day by and through the discoveries of scientific living. This need for expression and application on the part of the pupil and the tremendous present-day opportunity for satisfying this need through the junior-senior high school is the theme of this article." Dr. Wood has contributed many science articles to educational and scientific periodicals. Among his recent activities he has participated in making movie and movie-talkie films.*

J. M. G.

We are daily becoming more accustomed to the reasonable idea that there must be a logical sequence of like subjects through the years of the secondary school if any permanent results are to be achieved by the pupil. We are fast adopting the idea that there is something more than the mere acquisition of facts or even principles in the pursuit of any worth-while subject in the secondary-school curriculum.

What then, are the chief objectives of education and in what ways are those objectives best obtained in the junior high school? We are pretty well agreed upon the proper

objectives of education but we are far from an agreement upon the best methods of attaining these objectives. Experiments are legion, but none has reached the point where it is conclusive and acceptable as a fundamental criterion for measuring future educational processes.

What, may it be asked, are some of the signposts which may lead us along the broad highway of educational progress in the teaching of science in the junior high school?

1. It is every year becoming more apparent that science teaching should begin with the primary grades and continue throughout the twelve years. New York State has adopted such a program and its State Department of Education has appointed committees which have completed courses or are about to complete courses covering the first nine years.

2. It is a fundamental principle that in no one subject can a child assimilate the whole of its content in any one year or even a sequence of years, because the mind of a child, especially of the seventh year is so different from that of the ninth year in its capacity to absorb, integrate, and assimilate fundamental concepts. The seventh-year mind demands *concrete* concepts. The ninth-year mind may be able to generalize upon these concrete concepts and arrive at simple abstract concepts or principles.

3. It is essential that any subject adjustable to the changing mind of the junior-high-school pupil must possess the characteristics of integration and dependent continuity which psychologically characterize the child's mental growth, so that definite objectives be obtained in a gradual, systematic, practical manner and thus be pyramided or become accumulative throughout the years.

4. The acquisition of facts may be desirable as one of the objectives in any subject at any age. But if that be the chief objective its only limit is the number of facts we can get the child to absorb, retain, and regurgitate under the proper stimulus. If, on the other hand, the objective be the acquisition of definite ideals of *knowing* and *appreciating* the *environment* through the proper applications of the methods of science, then there *must* be a definite *continuity* in the *content* and *concepts* of the science matching the natural continuity of development of the psychological powers of the child.

The four fundamental objectives of education as outlined in the Sixth Yearbook, Department of Superintendence, National Education Association, are eminently reasonable and sound, it seems to me. They may be summed up in one statement as follows: to teach the child the value of self (conservation of life); the relation of self to the environment; the relation of self to his neighbor and to organized society, and the relation of self to universal law and to God.

Let us examine the subject of science and see how it is fitted to realize this fourfold objective as a three-year sequence in the junior high school.

The first question that we must answer concerning the teaching of science or any other subject is this: Does the learning of facts per se best tend to the realization of the fourfold objective in education named above or does some other content better do this? The reasonable answer to this question is, it seems to me, as follows: While facts are in a sense basic to an understanding of principles in any subject and especially in science, they must be considered as but a means to an end, which is the best possible adjustment of the individual to an understanding of self, nature, society, and universal law. Facts alone will never accomplish these objectives. But the development of *skills, abilities,* and *attitudes* leading to health, understanding, proper motivation, fine appreciation, real adjustments, and the development of what creative ability nature has given the indi-

vidual child are only possible through the solving of *concrete problems* in which the *apparatus, materials,* and the *self-activity* of the pupil are fully enlisted and used.

In this manner and in this manner alone, are we beginning to believe that *all* facts and *all* phenomena which can be logically presented in a science course are capable of being amalgamated with the everyday experiences and emotions of the child by means of the flame of enthusiasm of the well-trained teacher. In this manner and in this manner alone can we hope to make the child see his life in the schoolroom as a *unit,* get him to realize that he is living his life *now,* and make him feel that his school years are not primarily a preparation for life as he shall find it after he emerges from the secondary school and submerges himself in the complex life of today.

Now any intelligent person will admit that science is preëminently fitted to place within the reach of the pupil the apparatus, the materials, the phenomena, the facts, and the principles of his environment, because these things are the warp and woof of science. We might go even further and say that they are the actual framework which is to be riveted together by means of well-directed pupil self-activities and clothed by the pupil with the true meanings and significances. That these vital things of science are always properly placed within reach of the pupil no one is rash enough to assert. But that is a matter of method, which will always bear improvement, while the elements of science mentioned above are fundamental and eternal.

But it may also be asserted with little fear of contradiction that by no wild stretch of the imagination will it ever be possible to use these important tools of science in such a way as to realize these highly commendable objectives in education unless such work becomes progressive through a real science sequence through the three years of the junior high school. The importance of sequences has been recognized now for several years in the ancient-language, modern-language, and mathematics groups of studies. Comprehensive tests given at the end of two-, three-, and four-year sequences presuppose a continuation and pyramiding of concepts suited to the psychological age of the pupil.

Science must also adopt the same sequence for identical reasons not only through the junior-high-school years, but also during the senior-high-school years.

The average educated man or woman does not think of his or her daily activities in terms of language, mathematics, history, sociology, or any of the special sciences, but every fact and experience is grist for his or her mill of experiences, generalizations, and applications in doing the everyday job and in accomplishing something worth while. All concepts, all questions are sensed as concrete problems and the man or woman of real ability is he or she who is able to draw upon facts, concepts, and principles from every field of human knowledge and then concentrate them upon the solution of the very real problems demanding immediate solution.

Moreover, such problems do not come intermittently day by day nor are they faced for a year and then dropped. Such problems face the active man or woman through life and they grow strong and capable through the constant struggle involved in integrating the necessary facts and principles and in their applications to the final solution.

What subject, may it be asked, is better adapted to the presentation of just such concrete problems as are met in daily life than general science with its materials, facts, apparatus, natural phenomena, problems, and principles? Moreover, what subject is better fitted to bring the pupil to the realization of the fact that he is now facing in a practical way some of his life problems?

If we answer the above two questions in the negative or fail to present a subject better fitted to accomplish the objectives before mentioned, then the only possible chance we shall ever have of realizing these highly desirable objectives is through the insistence of a full three years' continuity or sequence of science in the junior high school.

Again, shall the junior high school present merely organized knowledge, which is a great step over the mere acquisition of facts, or shall it assume definite responsibility for *right attitudes, ideals,* and *abilities* in leading the pupil *to adventure* and *to create?* For, in the last analysis, developed abilities largely determine what shall be done with knowledge either organized into workable wholes or into isolated units.

Modern society is not so much concerned with the mere acquisition of knowledge, important and desirable as that may be. It is more concerned with what use the individual makes of that knowledge in the development of his individuality, in adjusting himself to the necessary conditions of his environment in his chosen field of work, or in submitting ideas by means of which that environment may be changed for the better. This alone makes him an integral part of society and guarantees him success because of his thorough understanding and appreciation of the law and order of the universe of which he is a part.

Organized knowledge alone, therefore, will never accomplish the necessary many-sided adjustments of our modern complex life. What, then, can *one* or even *two* years of science teaching, given here and there at random during the secondary-school years, do towards reaching even this *first* stage in the child's development? The only answer is a three-year, graduated course during the junior-high-school years not only for its intrinsic value in itself as *life,* but also as a basis for a progressive development of the means for realizing the four objectives of education through a *unified* science sequence during the four years of the senior high school. If a science sequence is good for three years, it is preëminently good for six years or even more than that.

Thinking straight is going to be the ultimate salvation of our social fabric whether in the scientific, political, educational, social, or religious fields of endeavor. But we are forced to do real thinking only by constantly facing the "forked-road" situations in life. It remains for us to clothe them with moral attributes which affect the actions of people if we are to make the world a better and a safer place in which to live.

In my opinion, no subject in our secondary-school curriculum is so well adapted as general science to bring the pupil face to face with "forked-road" problems and moral teachings resulting from the realization that law is law and can never be violated without the one violating it being made to suffer the natural penalties of such violation. Such daily realizations must in the long run lead towards right actions.

In direct opposition to the three-year sequence in science here advocated, there are many persons who insist that three years of general science be condensed and relegated to the seventh and eighth years of the junior high school to make room for elementary biology in the ninth year.

The obvious answer to this is that one might as well talk of eating his breakfast, lunch, and supper at one sitting as to argue for this procedure in science sequence. The pupil of the seventh, eighth, and ninth years is not psychologically fitted to assimilate three years' work in two, even if radical cuts were made in the ninth-year work. Again, the seventh- and eighth-year pupils are not fitted psychologically to assimilate the concepts of the ninth-year work, just as many tenth-year pupils are not psychologically fitted to grasp principles developed in

eleventh- and twelfth-year advanced biology, physics, or chemistry.

Furthermore, to accomplish any real results in the work of reaching any of the four objectives of education, five periods per week would have to be given in each year. At the present time this is impossible. Three periods per week is the best that can be expected in the seventh and eighth years and five in the ninth year. To give more would actually result in mental indigestion and largely eliminate the use of actual *contacts* which are so necessary in the development of skills and abilities fundamental to a realization of the objectives of education.

As already stated the mind of the seventh-year pupil is far different from the mind of the ninth-year pupil. It is also true that there are materials, apparatus, facts, etc., in the environment better adapted to the seventh-year pupil than to the ninth-year pupil. The same idea applies also to the eighth year in comparison to the ninth year. The problem of education, then, is the proper adjustment of materials and methods to the psychological capacities and characteristics of the different years. Can any one argue that such adjustments may be recognized and brought about in science teaching in the junior high school without a three-year sequence?

The smooth working of two engaged cogwheels is predicated upon the proper alignment, adjustment, and oiling of the teeth. In exactly the same manner must the materials and methods of science teaching be aligned and adjusted to the mental needs and capacities of the seventh-, eighth-, and ninth-year pupil if the four objectives of education are even approached.

The question may now be fairly asked: What are the natural capacities of the child and what are the materials and methods related to the environment which may be aligned and adjusted in each of the three junior-high-school years, and how may such adjustments be made?

The answer to this important question is a tentative one because we are just beginning to understand the problem and to experiment in its solution. In 1924 a committee of five, of which the writer was chairman, was appointed by the New York State Department of Education to write a three-year sequence syllabus in general science covering the seventh, eighth, and ninth years. With no preecdents (so far as we could learn) in the whole United States to guide it, the committee set to work to gather every scrap of information obtainable from every State in the Union and from over sixty of the larger cities relative to this three-year sequence. What the committee received bearing on this specific problem could be typewritten on a half-dozen business-sized sheets of paper. In June 1925 the three-year sequence course of study was published, and it still stands without change the authorized course of study for the junior high schools in the State of New York. What were the guideposts which aided the committee in the formulation of this three-year course? Here are a few of them.

It has been proved by experiment that the average child of the seventh year can *observe* the natural phenomena about him better than he can *generalize* upon them. Consequently the observational study of birds, trees, water, life in the water, rocks, earth, and sky are all acceptable topics of study in this year. This is the material which forms the cogs, so to speak, in the wheel of the environment. On the other hand, the seventh year is the beginning of the flowering of the individualistic period in childhood when observational work on the phenomena of nature, some of their natural relationships, and the reporting of them is particularly agreeable to the pupil. The spirit of rivalry is rampant. The "I saw something that you didn't see" spirit predominates. These characteristics are some of the teeth in the cogwheel of the mind.

The task of the teacher is to adjust the two sets of cogs (mind and environment) so that the pupil becomes aware and appreciative of his natural environment and senses something of its significance. To insist upon correct observations and exact reporting of them; to cause the pupil to become fully familiar with various common natural phenomena is the task of the teacher. These activities are largely the accumulation of facts and the questions involved most often begin with "What." These are the means by which the teacher adjusts and aligns the cogs of mind and environment. Because of these basic considerations the committee called the seventh-year course "Our Environment: How We Are Related To It."

The eighth-year pupil continues his observations and begins to reflect upon them. He begins to see real relationships between the factors of his environment. Adaptations to environment begin to enlist his attention and interest. He often meets questions beginning with "How." He more fully realizes the necessity for correct observations and their simple interpretation. His mental characteristics help him here. He is just entering the "gang" age and the club stage of social organization. He must explain everything. He gets for the first time an insight into the scientific method. He sees the necessity of adopting proper rules of health. He finds it a good policy to adjust himself, at least partially, to his fellow pupils, teachers, and elders. Here he meets for the first time some of the great contributions of scientists and sees their influence upon our social and industrial fabric. Thus he humanizes his science and satisfies, in part at least, his hunger for hero worship. He meets for the first time the study of the inexorable law of gravitation, its importance in our solar system, and its usefulness in everyday life. More original thinking is required in this grade. This comes through a study of the ways and means by which plants and animals and man adapt themselves in structure and habits to natural laws. He sees the importance of coöperation in securing pure water for the community, proper sewage control, efficient fire control, good general sanitation, and conservation in the garden and in the home. He is beginning to face the significance of universal law.

In this year materials, methods, and mental characteristics are more closely aligned than in the seventh year. The committee called the eighth-year course "Our Environment: How We Adapt Ourselves To It."

Finally, the ninth year presents a new problem. Here are presented the mechanics of air, water, heat, light, electricity, and (optional) their application to selected industries (manufacturing, transportation, agriculture, etc.) and public utilities (power plants, communication, etc.). Then follows the relation of solar energy to weather, plants, and animals with emphasis upon human physiology and hygiene and the protection of the individual through hygienic rules carried out. The pupil is also impressed by the need of a high development of the nervous system and the protection of the community from disease by concerted community action.

In connection with these topics, there is developed a relatively high order of observational and interpretative ability. Deferred judgment becomes more or less automatic in the solving of problems. For the first time the pupil begins a serious study of the relationships between *cause* and *effect*. He here most often faces questions beginning with "Why" and "How." He begins to control his environment and make it do things for him. This content coincides with the pupil's eagerness for construction, contacts, and development of manual and mental skills. He takes pride in doing something distinctive. He begins to see that he is master of his fate. For these reasons the committee called the ninth-

year course "Our Environment: How We Use and Control It."

In this year we have the closest alignment of the cogs of the mind and the materials and methods of the environment because experimentation and demonstration work lead all other activities.

Can any one claim that anything less than three years in science in the junior high school is needed to consummate this reasonable and logical program?

In conclusion it may be of interest to add that the New York State Department of Education is about to appoint a committee to write a new course in general biology for the tenth year which shall be a logical sequence of the three-year science sequence already adopted and outlined above. Thus the three-year science constant for the junior high school has been permanently adopted in New York State with the ninth year the basic science for any two- or three-year science sequences in the senior high school. It is also being used as a pivot around which will revolve the science of the first six years and the science of the last three years of the senior high school, inasmuch as there is a strong probability that the present physics and chemistry courses will be rewritten in the near future to align themselves with the science sequence of the first ten years. Such a sequence is now being tried out for the last six years at Rochester, N. Y., under the close supervision of Mr. Harry A. Carpenter, a specialist in science and a member of the committee that wrote the three-year sequence syllabus in general science briefly outlined above.

THE PURPOSES OF EXPLORATION AND ORIENTATION IN SECONDARY EDUCATION DEMAND SCIENCE AS A REQUIRED SUBJECT IN THE JUNIOR HIGH SCHOOLS

MORRIS MEISTER

EDITOR'S NOTE: *Dr. Meister is a teacher of teachers at the New York Training School. He was associated formerly with Dr. Joseph K. Van Denburg in the Speyer Experimental Junior High School. Dr. Van Denburg has said of the science department: "No science class I had ever seen could in a similar period of time show worth-while results equal to those demonstrated by Mr. Meister's pupils." Dr. Meister's own faith is expressed in his article—"The materials and activities of science study are admirably suited for the initiation of the boy and girl into habits of thinking which have social consequences of the most far-reaching nature."*

J. M. G.

The junior-high-school movement in its modern form has been developing for twenty years. During that time it has won over many of the opposition. Those who are still critical are not so outspoken as they used to be, and even their criticism indicates a recognition of the junior high school as a type of secondary education. It would seem, therefore, that much of the energy which at first was needed to convince administrators can now be spent in advancing the idea towards its goal. In the beginning there were claims to be put forth and objections to be answered. Advocates of the new type of school devoted themselves assiduously to the task of creating a vision.

That this vision has great appeal is evident in the large measure of success which has come. Yet it is necessary now more than ever to put certain of the "claims" into effect. Among the very important objectives originally set forth was that "*the*

junior high school will make easier desired reforms in curricula, courses of study, and extracurricular activities."[1] When advocates were pressed for further analysis of such desired reforms, the terms "exploration" and "orientation" were selected to express the need for greater attention to the individual and to individual differences. As Van Denburg puts it, "Rather than to remodel our seventh and eighth years (an almost impossible task) is it not easier to begin our seventh year with a clean slate and to build up . . . a course of study . . . which is designed for the one great purpose of better fitting those who follow it to do better the work in school, or out, that lies just ahead?"[2] Not knowing exactly what "lies just ahead" for each boy or girl, "try-out" courses of many kinds are developed. The attempt is made to "explore" individual interests and capacities by exposing the pupil to a wide variety of subject matter and activities. Unfortunately, however, the slate is rarely wiped clean. Old points of view are retained. Logical organizations, desired sequences, and even formal discipline dominate to a large extent many of the curricula and courses of study. Often the desire to be classified as a secondary school results in an imitation of the senior high school. Subjects and activities of great exploratory value are either omitted or are left struggling for adequate recognition.

It seems hardly necessary to establish the importance of science in modern life; yet the study of science is not at all a "major" subject in the junior-high-school curriculum. In an investigation by Pruitt[3] on the status of junior-high-school science, it is reported that of 42 States, only 11 required general science—at least for some students—although 30 recommended a science in one or more of the three years. Of 42 city courses examined by Pruitt, only 21 required science, at least for some students, though all but 2 recommended it. In a study by Tryon, Smith, and Rood[4] of the curricula of 78 junior high schools, 22 cities are reported as requiring science in the seventh grade, 40 in the eighth grade, and 21 in the ninth grade.

Careful examination of actual practices would reveal an even smaller emphasis on science than the above figures indicate for the time allotment is often small and the special equipment, so essential to science study, is wholly inadequate.

In urging science as a subject of the first magnitude we are mindful of the basic aims of the junior high school. Only in so far as science can contribute to individual needs and adapt itself to individual differences may it lay claim to an important place in the curriculum. But before we present the special qualifications of science, it would be well to inquire somewhat closely into the significance of the terms "exploration" and "orientation."

First, what is it that we wish to explore? Two fields present themselves—the pupil and the curriculum. We probe the mind of the early adolescent, seeking symptoms of permanent interests, inclinations, talents and capacities. Also, we make brief expeditions into the realm of knowledges; we sample our "social heritage" in order to discover subject matter and activities useful in developing the symptoms we seek. Though for purposes of analysis exploration may be regarded as a twofold process it must, in practice, function as a single process. An interest always shows itself as an interest in something, and a capacity always as a capacity to do something. On the other hand, where exploration has resulted in an extensive series of "try-outs"

[1] Thomas H. Briggs, *The Junior High School* (Houghton Mifflin, 1920), p. 68.

[2] Joseph King Van Denburg, *The Junior High School Idea* (New York: Henry Holt, 1922), p. 13.

[3] C. M. Pruitt, "Status of General Science as Revealed through State and City Courses of Study," *General Science Quarterly*, January 1928, pp. 367-381.

[4] R. M. Tryon, H. L. Smith, and A. F. Rood, "Program Studies in Seventy-Eight Junior High Schools," *School Review*, February 1927, p. 96-107.

courses without reference to the individual, few discoveries have been made.

Secondly, the exploratory process operates in the complete life of the pupil, not merely in that part of it which he spends within the classroom. So much that is vital to the boy or girl takes place outside of schooltime that we should seriously minimize our chances of real discovery if we did not devote ourselves emphatically to what is usually called extracurricular activities.

Thirdly, exploration implies a certain amount of wasted effort. If we always knew exactly what and where things were, we should not need to explore. Even in such carefully planned exploration projects as that of Commander Byrd, there is the ever-present possibility that nothing important will be found. We must therefore expect that our junior high schools will fail in certain cases to bring about complete orientation; that for some, exploration will yield meager results.

Finally, the orientation of the pupil must be with reference to more than future vocation. Important as is the gaining of a livelihood, one must not exclude nonvocational interests. The purposes of exploration and orientation include an adjustment of the individual to his environment in all of its aspects.

It would seem, then, that a major subject in a junior-high-school curriculum must meet at least the following criteria.

1. Is the material or activity worth while in itself and to the pupil?

2. Does it open up fields for future work and study?

3. Does it contribute to the probable future life of the pupil by providing him with

   a) Certain basic ideas and concepts?

   b) Certain basic skills and habits?

Aside from effectiveness of teaching and of the teacher, science subject matter appeals to the young adolescent as being worth while. Even if we did not live in an age when food, shelter, communication, transportation, and recreation all stress the achievements of science, still the mystery of natural phenomena and one's instinctive curiosity about environmental occurrences would make the study of science interesting. The proof of this inherent appeal lies not in what teachers of science have been able to develop in their classes, but in the independent out-of-school activities of pupils.

The writer has had an opportunity to study these activities through the medium of a publication which is sent monthly to about twenty thousand pupils of junior-high-school age.[5] More than ten thousand are members of science clubs. These clubs, five hundred in number, and growing constantly, are "registered" with this publication. They are effectively organized and most of them have filed their programs for the year. Though most of the clubs are sponsored by the science teacher, their activities reflect an interest which is much wider than the course of study in science. Indeed, rather than being an outgrowth of class activity, the club is used constantly by the teacher to bolster up the curricular work. So far has this gone in many instances, that it is difficult to distinguish the line of demarcation between club and class. Thus, science study lends itself readily to the extracurricular approach which for the early adolescent possesses great exploratory value.

Science study under effective guidance opens up vistas of the world as it is, and as it might be. Also, it is natural that the youth should identify himself for brief periods of time with the scientific achievements about which he is learning. To study the airplane carries with it the thought, "Could I be an aviator?" To consider the radio raises the question, "Could I become a radio engineer?" These inquiries may be vague, transitory, and perhaps subconscious;

[5] *Science Classroom*, Popular Science Publishing Company.

but in their cumulative effect they explore the possibilities of the individual.

No subject reflects the world of commerce and industry so well as does science. The things that men do and the things that men create in this modern age are largely the products of science. The last twenty years have brought a revolution in occupation and in vocation. It would seem, too, that still greater changes lie just ahead. Though it is difficult to make predictions, we can surely look to science as the source and the spirit of the immediate future. "What can I do in this new world?" asks the youth. In the study of science he glimpses a variety of answers. There are, first, the immediate and practical possibilities of electrician, plumber, mechanic, motion-picture operator, etc. On perhaps a higher level there is the salesman of commodities scientific in nature, the repair man, the inspector, the storekeeper, etc. If he be ambitious, there is also the engineer, the inventor, the contractor, the financier, etc. Finally, there is the field of research, either in industry or in the university.

The severest criticism of our present civilization is implied in the term "machine age." Mass production and the needs of efficiency have resulted in automatic machines which utilize the operator as merely another cog. If there is any hope for happiness in work for the men and women in modern factories it must surely be in a knowledge of the process—in a view of the whole to which they contribute so small yet so necessary a part. Here, too, the course in science can make a contribution.

When we consider the probable future life of the pupil we must look often to the contributions of modern science. In this connection, it is interesting to note that junior-high-school science has become largely a course in *general* science. The development of this course has paralleled the development of the junior high school, in that it represented a reaction against college domination, avoided the highly specialized point of view, and centered its attention on the pupil rather than on subject matter. There have been many types of general science. Since the early days when the term "hodgepodge" expressed a dissatisfaction with its fragmentary nature, the course has lived through a "practical-applications" stage, a "popular-science" stage, a "civic-science" stage and the "environmental" point of view. At each of these levels of development there was distinct exploratory value for the junior-high-school pupil.

The most recent growth, however, makes the subject indispensable for the purposes of exploration and for meeting the third of the criteria set up elsewhere in this paper. This growth does not set aside the environment or its interpretation as an aim, but it transfers the emphasis to a relatively small number of fundamental science concepts necessary for effective living. Through careful analysis of the popular writings of scientists and by means of other special techniques statistically valid, such science concepts have been and are being developed. The keynote of these basic ideas is the pupil's probable future life, vocational, avocational, and cultural.

Correlative with this recent trend is the attention paid to habits and attitudes. The scientific habit of mind has become for many the outstanding objective of science teaching, for the scientist's method of thinking and of discovering truth is the most valuable contribution of science to the world. The materials and activities of science study are admirably suited for the initiation of the boy or girl into habits of thinking which have social consequences of the most far-reaching nature.

In order to achieve these newer aims, science syllabi are utilizing environmental subject matter and basic concepts to develop such attitudes as that of

a) basing conclusions on facts

b) readiness to change opinion when new facts are discovered

c) testing opinion before acceptance

d) desire to know the truth rather than to win

e) desire to look for adequate cause for every effect

In several recently developed science courses, the time allotment is adjusted so that at least half the available energy of the pupil is turned to a wide variety of "supplementary" or "outgrowth" activities. The latter follow from basic conceptions carefully built up. The syllabus suggests a variety of outgrowths, with the understanding that all of them need not be included nor need any one be included for all. This type of material and such treatment are the most thorough recognition of the principle of exploration yet attempted.

Though science courses are not generally of the kind described above, the movement in that direction is strong and rapid. Should the development be only partially successful, it is difficult to see how any subject can serve the fundamental purposes of the junior high school any better than can science.

AN EVALUATION OF INDIVIDUAL AND LECTURE-DEMONSTRATION LABORATORY METHODS FOR HIGH-SCHOOL SCIENCE

C. C. WEIDEMANN

EDITOR'S NOTE: *Dr. Weidemann is director of the Bureau of Educational Reference and Research and professor of history and principles of education, Teachers College, University of Nebraska. He has been head of the chemistry department, A to Zed High School, Berkeley, California, and chief control chemist in the Western Industries Company.*

Dr. Weidemann is the author of "How to Construct the True-False Examination," "Survey of College Examinations" (co-author, Ben D. Wood), "Adventures with Home-Made Musical Instruments," and is responsible for the Educational Research Record, *official organ of the Bureau of Educational Reference and Research.*

Summarizing the factual material of his article, Dr. Weidemann says: "In the writer's judgment the data included in this digest favor the demonstration method in terms of realizing the possibilities of both the general objectives as well as the specific science objectives of the junior high school." J. M. G.

Is the individual laboratory method better than the lecture-demonstration method for high-school science instruction? This article includes:

1. Brief statements of the general purposes of junior-high-school science
2. Summarized statements of the specific purposes of junior-high-school science
3. A digest of significant studies which compare the individual and lecture-demonstration methods
4. An evaluation of the two methods of instruction in science with particular reference to the junior high school

In the main, the general purposes[1] of the junior high school are:

1. To provide a suitable educational environment for children approximately twelve to sixteen years of age
2. To explore the interests, abilities, and aptitudes of children of junior-high-school age
3. To explore the major fields of human endeavor

[1] W. A. Smith, *The Junior High School*, (New York: The Macmillan Company, 1926), pp. 150-206. Smith lists Francis, Davis, Bunker, Johnston, Wert, Horn, Cox, Bonser, Jones, Bennett, Snedden, Inglis, Judd, Van Denburg, Briggs, and Koos as representative leaders in the junior-high-school movement.

4. To provide for individual differences.

5. To continue common integrating education

6. To provide for socialization

7. To democratize the school system

Educational authorities[2] in science differ somewhat regarding the specific purposes of secondary science instruction. A summary of the specific purposes of science instruction for the junior high school is:

1. To reveal the leading divisions of science knowledge

2. To teach the scientific method of problem solving

3. To provide types of experiences and activities in science which contribute to the development of the scientific attitude—a working belief in guidance by truth—towards common phenomena

4. To be a purposeful and enjoyable part of the life and thought of the pupils facing significant social and civic problems as young members of any modern community

5. To provide various and challenging science experiences, so that the pupil may discover and develop as much as possible his dominating interests in science

6. To stimulate a desire for the further study of science as a basis for educational and vocational guidance

7. To aid pupils to perceive new beauty in and to increase their power to understand, enjoy, and appreciate scientific phenomena

8. To provide a program of science instruction which is articulated with the subject matter and methods of the elementary grades as well as with the subject matter and methods of the senior high school

[2] (a) Bureau of Education, Bulletin, 1920, No. 26, "Reorganization of Science in Secondary Schools." (b) J. O. Frank, *How to Teach General Science* (Philadelphia: P. Blakiston's Son and Company, 1926). (c) C. J. Pieper, and W. L. Beauchamp, *Teacher's Guidebook for Everyday Problems in Science* (New York: Scott, Foresman and Company, 1927). (d) O. W. Caldwell, and F. D. Curtis, *Introduction to Science* (New York: Ginn and Company, 1929). (e) O. W. Caldwell, "What about Jnuior High School Science?" *The Twenty Grades* (New York: Ginn and Company, 1930), p. 3.

A digest of investigations up to 1925 relative to the merits of the lecture-demonstration and the individual laboratory methods of instruction in science has been admirably summarized by Downing[3] as follows:

William H. Wiley, "An Experimental Study of Methods in Teaching High School Chemistry," *Journal of Educational Psychology*, IX, April, 1918, pp. 181-98.

Harry A. Cunningham, "Under what Conditions, in High School Science, is Individual Laboratory Work Preferable and When does the Lecture-Demonstration Give Better Results?" unpublished master's thesis, Department of Education, University of Chicago, 1920, p. 56 ("Individual Laboratory Work versus Lecture-Demonstration," and abstract of this thesis, appeared in "The Proceedings of the High School Conference of November 18, 19, and 20, 1920," University of Illinois *Bulletin*, XVIII, 14).

Thomas D. Phillips, "A Study of Notebook and Laboratory Work as an Effective Aid in Science Teaching," *School Review*, XXVIII, June, 1920. pp. 145-53.

J. L. Cooprider, "Oral versus Written Instruction and Demonstration versus Individual Work in High School Science," unpublished master's thesis, University of Chicago, 1922. A summary of this thesis appeared in *School Science and Mathematics*, XXII, December, 1922, pp. 838-44.

E. W. Kiebler and Clifford Woody, "The Individual Laboratory versus the Demonstration Method of Teaching Physics," *Journal of Educational Research*, VII, January, 1923, pp. 50-58.

J. L. Cooprider, "Laboratory Methods in High School Science," *School Science and Mathematics*, XXIII, June, 1923, pp. 526-30.

Harry A. Cunningham, "Laboratory Methods in Natural Science Teaching," *School Science and Mathematics*, XXIV, October and November, 1924, pp. 709-15 and 848-51.

Fred G. Anibal, "A Comparative Study of the Effectiveness of Teaching High School Chemistry through Individual Laboratory Experimentation and Lecture-Demonstration," unpublished master's thesis, School of Education, University of Chicago, 1924, p. 69. This report is based on two studies in successive years.

A similar review of the studies by Cooprider, Cunningham, Wiley, Kiebler, and Woody is included by Curtis[4] in his volume

[3] Elliott R. Downing, *The School Review*, XXXIII, No. 9, November 1925.

[4] F. D. Curtis, *A Digest of Investigations in the Teaching of Science* (Philadelphia: P. Blakiston's Son and Company, 1926).

devoted to a summary of studies in science teaching.

Both Downing and Curtis summarize the foregoing studies to the effect that:

1. The lecture-demonstration method is superior to the individual laboratory method, in so far as the immediate results of imparting information to the pupils is concerned

2. The individual laboratory method is superior to the lecture-demonstration method, in so far as the retention of information by the pupils is concerned

It seems appropriate to point out, however, that the average per cent differences between the two methods as reported by each investigator are hardly conclusively significant for either the "immediate results of imparting information" or "retention of information" from the standpoint of choice of method for instructional purposes.

The findings of Anibal agree with the foregoing summary. Although the study by Phillips was probably less objective in its techniques of procedure, still the author's conclusion indicates that the individual laboratory method has no significant advantage over the lecture-demonstration method.

These investigations, in the main, relied upon two or more equivalent sections of pupils. Equivalency was limited to intelligence-test scores or such scores combined with teachers' grades.

1. By the individual laboratory method the pupils received their instructions either in writing or orally. They proceed with the laboratory assignment without the assistance of the teacher.

2. By the lecture-demonstration method the instructor performs the experiment and closely follows the laboratory instructions, with the exception of the use of the personal pronoun.

In all other respects, such as textbook, notebook, and recitation activities, the two methods are alike for every section. It seems that every reasonable effort has been made to avoid the possible criticism that the results are not valid because the methods of instruction actually used were a mixture of both the individual laboratory and lecture-demonstration methods.

A few other comparisons indicate that:

1. The individual laboratory method requires much more time than the lecture-demonstration method. Both Cooprider and Cunningham make such a report.

2. The lecture-demonstration method requires fewer items of supply and equipment than the individual laboratory method and therefore, according to Anibal, is very much less expensive upon a class basis of 30 pupils.

3. Anibal in his first study rather favors the thought that the lecture-demonstration method is superior to the individual laboratory method in the case of bright pupils. The number of cases, however, were only 23. In his second study the reverse seemed true. Cunningham states a very probable conclusion that the evidence to date is such that "neither method seems to be better for slow students than for bright ones."

4. According to Kiebler and Woody the lecture-demonstration method is superior to the individual laboratory method in developing the pupil's ability to attack independently new problem situations.

5. Again Kiebler and Woody favor the individual laboratory method for experiments difficult to perform.

These studies are pioneer efforts and are to be commended as worthy of thoughtful consideration. The data in a collective sense are inadequate. These studies are based on averages, involve too few cases, are based upon periods of experimentation that are too brief, and in general neglect the needs of the individual pupil in favor of the group.

Since 1925, the more significant studies have been:

W. W. Carpenter, "Certain Phases of the Administration of High School Chemistry," Contributions to Education, No. 191, Teachers College, Columbia University, 1925.

C. H. Walter, "A Comparative Study of the Teacher Demonstration and the Individual Laboratory Methods in Physics," School of Education, University of Chicago, 1926.

W. W. Knox, "The Demonstration Method versus the Laboratory Method of Teaching High School Chemistry," *School Review*, XXXV, pp. 376-86.

H. B. Nash, and M. J. W. Phillips, "A Study of the Relative Value of Three Methods of Teaching High School Chemistry," *Journal of Educational Research*, XV, 5, pp. 371-79.

R. E. Horton, "Measurable Outcomes of Individual Laboratory Work in High School Chemistry," Contributions to Education, No. 303, Teachers College, Columbia University, 1928.

Carpenter had test results from 34 high-school chemistry classes in 23 schools located in 14 States. The total number of students performing each of 10 experiments by each of three methods was 4091. The 34 classes were divided into four groups as follows:

1. Group A consisted of 10 classes
2. Group B consisted of 10 classes
3. Group C consisted of 8 classes
4. Group D consisted of 6 classes

The methods were (1) the demonstration method; (2) the individual method; (3) the group-of-two method; and (4) the control in which the student took the examination before he performed the experiment. The general procedure was an adaptation of the rotation experimental method. The assembled results were evaluated by calculating the significance of the difference of the means with three times the probable error of the difference of the means as the criterion of significance.

About fifty per cent of the classes did better by the demonstration method than by the individual laboratory method; classes with more than twenty did better by the demonstration method; and classes with less than twenty did as well by the demonstration method as by the individual method. Carpenter concludes: "The results of this experiment point to the conclusion that the majority of students in high-school laboratory chemistry classes, taught by the demonstration method, succeed as well as when they perform the experiment individually, if success is measured by instruments which measure the same abilities as are measured by these tests; namely, specific information and ability to think in terms of chemistry."

Walter began with four equivalent classes of over thirty pupils each in high-school physics. Two classes were taught by the demonstration method, and two classes were taught by the individual laboratory method. The equivalency of the groups was established by using the former school grades of the pupils and two intelligence tests; the Otis Self-Administrative Tests of Mental Ability and the Army Group Examination Alpha. Forty pupils were finally selected for the demonstration group, each pupil being paired as to sex, intelligence, and former achievement with a pupil in the individual group. A rotation of technique of instruction was followed so that the demonstration group performed some of its experiments individually and the individual group had some of its experiments demonstrated. As soon as each experiment was completed, a test for immediate retention was given. Two weeks after each experiment, a test for delayed retention was given. At the end of the semester, three standardized tests were also administered. A test to measure the pupils' ability to use apparatus was used after each group had been given five experiments by each laboratory method.

Walter says, "In every case, the results have shown the demonstration-drill to be superior to the individual laboratory method in gaining knowledge of the experiment performed."

In the first delayed retention tests the difference in favor of the demonstration-drill method is 4.09 P. E.s. In the imme-

dinte-results test after the methods are reversed there is a difference of 4.47 P. E.s in favor of the demonstration-drill method. There seems to be no distinct disadvantage to pupils of different ability. Either method may be used to develop ability to solve problems and the economy in equipment again favors the demonstration-drill method. The individual method probably is superior in teaching the actual manipulation of apparatus.

Knox used four mentally equivalent groups containing dull, average, and bright pupils. The Miller Mental Ability Test was used. The lecture-demonstration groups consisted of 42 pupils and the individual and groups of two laboratory method consisted of 43 pupils. Both groups used the same textbooks, manuals, assignments, discussions, reports, directions for experiments, and the same kind, size, and amount of materials and apparatus. The work covered ten experiments.

One day after each experiment an objective test for immediate retention was given to all the pupils. Three weeks after each experiment, an objective test for delayed retention was given to all the pupils. At the end of the tenth experiment an objective test for method of attack was given to all the pupils. Each and every score was reduced to a sigma index basis. Table I compares the result by each method.

In each instance the lecture-demonstration is superior to the individual laboratory for teaching mentally heterogeneous groups.

Again for each laboratory method the Miller Mental Ability Test results were correlated with each of the three objective test results respectively. Table II contains these Pearson-r values.

The lecture-demonstration method provides greater opportunity for accomplishment in proportion to the pupil's mental ability than is offered by the individual laboratory method. The lecture-demonstration method is better adapted to individual differences.

Furthermore, the average sigma index placement of the pupils of inferior and superior mental ability were compared by each method for each of the three objective tests. See Table III.

For the inferior pupils, the individual laboratory was slightly superior to the lecture-demonstration method for all three objective tests. For the superior pupils, the lecture-demonstration was considerably superior to the individual laboratory for all three objective tests.

TABLE I

COMPARISON OF THE LECTURE-DEMONSTRATION AND INDIVIDUAL LABORATORY METHODS BY THREE TYPES OF OBJECTIVE TESTS

Type of Test	Method	
	Lecture Demonstration	Individual Laboratory
Immediate Retention.....	+0.077	−0.648
Delayed Retention.....	+0.375	−0.461
Method of Attack.....	+0.039	−0.022

TABLE II

PEARSON-r VALUES FOR EACH LABORATORY METHOD WHEN MILLER MENTAL TEST RESULTS ARE CORRELATED WITH EACH SET OF OBJECTIVE TEST RESULTS

Factors Correlated	Laboratory Methods	"r"	P. E. of "r"
Miller Mental Test and ImmediateRetention	Individual	+0.43	±0.09
	Lecture Demonstration	+0.64	±0.06
Miller Mental Test and Delayed Retention	Individual	+0.27	±0.09
	Lecture Demonstration	+0.53	±0.07
Miller Mental Test and Method of Attack	Individual	+0.38	±0.09
	Lecture Demonstration	+0.45	±0.08

TABLE III

COMPARISON OF THE AVERAGE SIGMA INDICES OF PUPILS OF INFERIOR AND SUPERIOR MENTAL ABILITY BY EACH LABORATORY METHOD FOR THE THREE OBJECTIVE TESTS

Type of Test	Kind of Pupil	Average Sigma Index by the	
		Individual Laboratory	Lecture Demonstration
Immediate Retention	Inf.	−0.73	−1.11
	Sup.	+0.32	+1.07
Delayed Retention	Inf.	−0.48	−0.53
	Sup.	+0.19	+0.85
Method of Attack	Inf.	−0.10	−0.24
	Sup.	+0.08	+0.48

The lecture-demonstration requires about one half as much time as the individual laboratory method.

In general, this study favors the lecture-demonstration method. The individual laboratory is slightly better for dull pupils. This study by Knox is not conclusive.

Nash and Phillips used three groups equivalent by the Miller Mental Ability Test, Form A. The so-called pupil group was permitted to finish the work as rapidly as desired. The combination method group used lecture-demonstration, individual laboratory, and the recitation. The instructor method group had textbook assignments, no recitations, no experimental materials, pupils asked questions and the instructor asked no questions. The instructor gave complete demonstrations or performed the experiments before the class, and did all the class work such as writing equations and solving problems. Pupils took notes. Over a five-month period, fifteen pupils were included in each of the three groups. Table IV says that within the limits of this experiment in acquiring information, the instructor method of teaching high-school chemistry is superior to the pupil and combination methods. This study is not conclusive.

TABLE IV

COMPARISON OF THREE LABORATORY METHODS THROUGH INITIAL AND FINAL TEST RESULTS

Group Method	Initial Test		Final Test		Gain	
	M	T	M	T	M	T
Pupil	23.2	12.4	48.8	16.5	25.6	18.6
Combination	15.5	10.2	47.8	17.0	32.3	11.0
Instructor	18.1	18.0	52.2	14.0	34.1	9.8

Over a total period of two school years, Horton reports pupils' reactions to the demonstration and individual laboratory methods in a high-school chemistry course in one school by means of written tests, individual performance tests, and class performance tests, requiring one period each week for demonstration and individual laboratory respectively. The demonstration group consisted of eighty-five pupils taught by three teachers. The individual group consisted of 379 pupils taught by seven teachers.

The validity coefficient of the written test was $r = +0.80 \mp 0.03$ with Regents' examination as the criterion. The index of reliability for odd and even halves was $r = +0.94$.

Over a period of eighteen weeks of actual instruction Table V indicates that the written test reveals an inconclusive difference in favor of the individual method, while the individual performance test reveals a significant and conclusive difference in favor of the individual method within the limits of the performance test as applied to one experiment. This experiment is inconclusive for an entire high-school chemistry course.

Questionnaire results from the pupils indicated that 87.3 per cent (296 out of 339) preferred the individual laboratory work.

TABLE V

COMPARISON OF THE INDIVIDUAL AND DEMONSTRATION METHODS BY WRITTEN AND INDIVIDUAL PERFORMANCE TESTS

Type of Test	Method	Mean	Standard Deviation	Difference of the Means	Significance of the Difference of the Mean
Written.....	Ind.	43.60	11.12	2.65	2.09
	Dem.	40.95	10.32		
Individual Performance.	Ind.	12.83	2.84	2.88	4.96
	Dem.	9.95	3.18		

In a nonwritten test of individual performance of manipulation of laboratory apparatus the individual excels the demonstration method with a reliability of 4.96 times the standard deviation of the difference.

In a group performance test involving manipulation of apparatus by means of the rotation experimental technique, the individual method is superior to the demonstration method when both speed and completeness are included. The reliability of the difference is 3.18 times the standard deviation of the difference.

In Horton's words, "Throughout this discussion, frequent contrast between the demonstration and individual laboratory work have been made. This much mooted question appears rather more complex than it has hitherto been considered. No simple answer as to which is superior can be given, but it is believed that the evidence presented in this study may assist in understanding at least the limitations of each method . . . we have overemphasized individual work as a means of acquiring information and of merely understanding chemistry . . . there seem to be important outcomes for individual work, measurable and attainable by suitable methods."

The foregoing investigations seem to warrant a summary as follows:

1. The economies of time and money favor the demonstration method. These may be relatively insignificant factors in studies concerned with the relative merits of any two or more laboratory methods of instruction.

2. Acquirement of information as an immediate result, in general, favors the demonstration method. In the cases of the results of delayed retention of information by inferior pupils, neither method is significantly superior to the other.

3. The individual method is superior to the demonstration method as a means of developing skill in manipulation of laboratory apparatus.

4. The accumulated evidence is insufficient to warrant final conclusions. It is sufficient however, to warrant a carefully controlled study adequately supported by sufficient funds for an extended period of time. Such a study should include a large number of pupils, and valid devices with which to measure every phase of instruction under both the individual and demonstration methods.

In the writer's judgment the data included in this digest favor the demonstration method in terms of realizing the possibilities of both the general objectives as well as the specific science objectives of the junior high school. The saving in time and money offers the possibility of a program of rich and challenging experiences and activities in science as a means (1) to explore the individual differences in interests, abilities, and aptitudes of pupils; (2) to reveal the many divisions of science that pupils may be stimulated with purposeful desires to study and enjoy science work; (3) to demonstrate the method of science, that a working belief in guidance by truth may be

established in every pupil; (4) to aid pupils to increase their powers of understanding and appreciating scientific phenomena; and (5) to prepare a pupil better to adjust himself in the science curriculum of the senior high school.

Furthermore, the foregoing studies have hardly touched the relative effectiveness of the individual and demonstration methods with respect to the specific science purposes numbered 2, 4, 5, 6, and 7. Nothing approaching an adequate answer to the question of this paper can be formulated until valid measures of appreciations and attitudes are assembled.

In conclusion, so far as the junior high school is concerned, much work needs to be done. The investigations to date have been executed with senior-high-school students and probably should be discounted somewhat in drawing inferences from them in terms of the junior high school.

THE SCIENCE CLUB IN THE JUNIOR HIGH SCHOOL

(What One Science Club is Doing)

HERBERT J. ARNOLD

EDITOR'S NOTE: *Mr. Arnold is a teacher of general science in the Lincoln School of Teachers College and instructor in science in Teachers College. His work in the management of science clubs is well and favorably known.*

Readers will enjoy the visualization of a club in session, the evaluation of the chief educational outcome of science clubs, the suggested constitution and club projects. Mr. Arnold gives science clubs a permanent place in secondary education by the judgment resulting from his experience—" the most important influence of the science club is the way in which it affects the attitudes of the students towards science."

J. R. C.

The time is Thursday afternoon at about three-thirty. The place is the general science laboratory. The four rows of tablet armchairs are filled with girls and boys from the seventh, eighth, and ninth grades. They are talking and asking each other questions about the weird-looking apparatus that covers the demonstration table at the front of the room. Two or three boys in rubber aprons are bustling to and fro; they are constructing some contrivance from glass tubes, rubber stoppers, and gleaming bottles. The meeting of the Science Club is about to start.

At the front of the room at the teacher's desk, flanked by the treasurer and secretary of the club, sits a young man of the tenth grade. Because of his advanced age, his dignity and scientific attainments, he has been elected president of the organization. He glances at the clock, rises, taps the desk three times with a wooden mallet, and says in a low but distinct voice, " The Science Club will please come to order."

The hum of voices ceases. The sergeant-at-arms, standing near the door, frowns at some youngster who is crossing the room and points to a seat at one of the tables in the rear of the room. Three late arrivals enter and find seats at these tables.

The president announces, " The secretary will now read the minutes." The secretary then rises and reads an account of the experiments which were performed and the reports which were given at the previous meeting. Two of the members make slight corrections and the minutes are accepted. The president asks whether there is any old or new business to come before the club.

and there being none he proceeds to the scientific part of the program.

"We shall now have the pleasure," says he, "of hearing a discussion of the properties and uses of a substance called thermite by William Jones. Mr. Jones, I may add for the benefit of the new members in the seventh grade, was the president of the club last year, and we are very glad to have him on the program. I believe that he will give us a convincing demonstration of the powers of this interesting substance. Mr. Jones."

Mr. Jones, a tall, slender, bespectacled youth, with dark hair and a serious face, walks to the front of the room and passes behind the demonstration table. "I have in this bottle," he says, "a small quantity of a powder called thermite, which I have made. It consists of a mixture of pulverized iron rust and powdered aluminum. I am going to weld two pieces of steel together with it. This small flowerpot, as you see, has a hole in the bottom. I am placing a small piece of paper over the hole, and now I am filling the pot half full with the thermite. Please watch carefully. I am placing on top of the thermite a little heap of a white powder called sodium peroxide, and in this heap I am inserting a strip of magnesium ribbon. I now place these two pieces of steel end to end on this block of soapstone, and I place this pot containing the thermite above the junction of the two pieces. No—I'd better heat them first."

He removes the flowerpot and with a Bunsen burner heats the two adjacent ends of the pieces of steel for about two minutes. Save for a whisper here and there as one youngster tells his friend what he thinks will happen, the room is still. All eyes are on the Bunsen burner, the pieces of steel, and the small flowerpot.

"Now," says Jones, "I think the ends of these pieces of steel are hot enough. I'll place this flowerpot over them so that the hole in its bottom lies over their ends. I shall now ask the people in the front row to leave their seats and to stand at the side of the room—they will see the reason for this in a few moments."

The youngsters in the first row do as requested, and the faculty adviser of the club leaves his seat near the rear of the room and moves up to a position at the side of the room near the table.

"I shall now light the magnesium ribbon which sticks up out of the flowerpot. Watch!" He tilts the Bunsen burner until the flame just touches the top of the metal strip. There is a wisp of smoke and then a very brilliant light like that of an electric arc. The rays of the winter sun slanting into the room seem dim by comparison.

"Don't look directly at the light—look off a bit to one side!" cautions the speaker. The bright flame has now burned below the rim of the flowerpot. There is a sputter, and suddenly a shower of sparks shoots out of the top of the flowerpot. The demonstrator steps back. A large circle of yellow light appears on the ceiling; the shower of sparks continues. The stuff inside the flowerpot must be white hot. Suddenly a glowing stream of molten metal pours out from the hole.

"Molten iron," shouts Jones, looking quite excited. "The temperature in that pot is about three thousand degrees centigrade!"

The shower of sparks becomes weaker and stops. Jones takes the glowing flowerpot with a pair of tongs, places it in the sink, and turns on the water. A loud hissing is heard which lasts for at least a minute, and great clouds of steam arise. The hissing dies away. The demonstrator takes hold of the end of one of the pieces of steel. He lifts it and the second piece is lifted with the first. They are joined by a still glowing chunk of iron. The two pieces have been welded into one!

Jones waits for the applause to die down and then says, "I should like to explain

why all this has taken place." And thereupon, as simply and clearly as he can, he explains the chemistry of the process. Some of the youngsters, now that the fireworks have ended, lean back in their seats, look blank, and appear politely bored by the explanation. Most of the audience, however, follows the explanation with eager eyes. The speaker writes a chemical equation on the board. Hands go up.

"What does that Fe mean?" asks one boy.

"But why use thermite?—I should think it would be safer and easier to solder steel pieces together," says a youngster with an inquiring mind but a very limited knowledge of metals.

"How do they know that the temperature produced by the reaction is three thousand degrees? I should think any thermometer would break if you put it in that pot," comments a third.

"Is thermite the stuff that burglars use in boring through a safe? I once read something like that in a detective story."

"I should think you'd get molten aluminum instead of molten iron—you put aluminum in, didn't you?"

"But *why* does aluminum displace iron from its oxides?" asks one budding chemist who has learned how to use chemical terms by working with his "chemcraft" set and manual. Jones can't answer this one, and appeals to the adviser of the club.

The teacher, who has been as unobtrusive as possible up to this time, makes a reference to something called the electromotive series of the metals and suggests that Jones report on it at some future meeting. He agrees to. The club applauds again and the speaker sits down.

The president rises and states, "The next part of our program will consists of an account of the discoveries made by archaeologists in the ruined city of Pompeii. Peggy Wilson is particularly well qualified to talk on this topic because she has walked through the ruined streets of Pompeii and has with her a number of curios which were found when the city was dug out of its covering of volcanic ash. Miss Wilson."

Thus starts the meeting of the Science Club of the Lincoln School of Teachers College—a group of young people who meet every two weeks to perform experiments, demonstrate apparatus, give reports on scientific topics, listen to scientific lectures, and to engage in anything of a scientific nature which will be of interest to them.

WHY A SCIENCE CLUB?

The science club is one of the best means of arousing and maintaining interest in science in any school. There is a difference between the atmosphere of the science class and that of the science club. In the science class there is certain work which must be accomplished—there are certain goals to be reached. The skillful teacher will, of course, set the stage so that the youngsters will feel as though the goals have been set by themselves. But the feeling that the work must not be sidetracked, the idea that certain things that come up, regardless of how interesting they may be, are irrelevant, cannot be divorced from the classroom. However, in the science club, anything pertaining to the field of science is in order. There are no irrelevancies. Immediately following a discussion and demonstration of the operation of an electric heater, one may quite properly consider the theories of the origin of the solar system. The science club, therefore, is an important supplement to the classwork in science, for it takes care of activities which might not fit into the program of work in a given science class.

By far the most important values of the science club, however, are those which its members derive from participating in its activities. In spite of the miscellaneous character of a science club program, the experiences which it furnishes its members are of importance in building up the large

scientific concepts, the development of which is an important aim of science education. I have tried to illustrate this in a previous article.[1]

Many other aims of science are never realized in the regular course in science in many schools. The skills necessary for one to manipulate apparatus intelligently are frequently neglected because of the lack of laboratory facilities. Interest in the various aspects of experimental science is closely bound up with the possession of these skills. The members of a science club who demonstrate to their fellow members acquire these skills. An attitude of interest towards science and the desire to spend one's leisure time in some scientific pursuit is frequently killed off by too much book work and drill for examinations. The people who attend the meetings of a well-conducted science club cannot but develop a lasting interest in some phase of science. Many of those who come around at first merely to see a good show become curious about the *why* and *how* of things and turn into serious and enthusiastic students of science. In short, then, probably the most important influence of the science club is the way in which it affects the attitudes of the students towards science.

Granting the value of a science club both to the pupils and to the school, what sort of club should one organize? All teachers who have worked with science clubs agree that the *general*-science club is the most lasting and arouses the most interest. Clubs in a single field of science—radio clubs, photography clubs, etc.—frequently expire in their infancy. They have several disadvantages, one of which is that many topics of great scientific interest to the average person are irrelevant in the field in which the club works and cannot be included in the program. Interest soon dies in such a club when the few enthusiastic leaders who were responsible for its organization far outstrip the majority of the members who have but a limited knowledge of the field. To the general-science club nothing scientific is foreign. The youngster who is ignorant of radio will not be discouraged and drop out when a young Marconi delivers a difficult lecture on the operation of the screen-grid tube; for *he* may have a chance to discuss the feeding habits of butterflies immediately after—a subject in which he is greatly interested and which he enjoys presenting to the group.

Dr. Meister[2] has described in excellent fashion a method of organizing a science club and has given many helpful hints with regard to its management. The constitution of the Lincoln School Science Club was written by a committee of members after a model worked out by Meister. Here it is:

The Constitution of the Lincoln School Science Club 1929-1930

Article 1. *Name*

The name of the organization shall be the Lincoln School Science Club.

*Article*2. *Purpose*

The purpose of this club shall be to promote an interest in science among the members of the club and among the students of the Lincoln School.

Article 3. *Membership*

Section 1

Any student in the high school of the Lincoln School may become a member.

Section 2

A person desirous of becoming a member shall apply in writing to the faculty adviser or officers of the club by placing a note in the Science Club box in room 413. Upon receiving a three-quarters vote of the club, he shall become a member.

Section 3

All except charter members shall be initiated in a method to be decided upon for each occasion.

Section 4

Any member failing to appear for three successive meetings shall be automatically dropped from membership. Any member failing to pay his dues for any meeting shall be dropped also.

[1] Herbert J. Arnold, "The Revelation of Nature through Science." *Child Study*, May, 1929.

[2] Morris Meister, "Managing a Science Club," *School Science and Mathematics*, XXIII, 3, March, 1923.

Article 4. Meetings

Section 1

A meeting shall be held every two weeks on Thursday from 3.20 to 4.45 p. m.

Section 2

The president with the approval of the other officers may call a special meeting at any time.

Article 5. Programs

Section 1

The business program shall never last longer than 15 minutes.

Section 2

The science program may take the following forms: lectures, demonstrations, trips, reports, discussions, etc.

Section 3

The officers and faculty adviser shall decide in advance on the program for each meeting.

Section 4

Any member desiring to speak at a meeting of the club shall place a note in the Science Club box in room 413 at least one week before the meeting.

Article 6. Dues

Section 1

The dues shall be $.05 a meeting.

Section 2

The money in the treasury of the club shall be used for apparatus, books, magazines, trips, etc., as the club may direct.

Section 3

Appropriations will be made by a two-thirds vote of the club.

Article 7. Officers

Section 1

The officers of the club shall be: president, vice-president, secretary, treasurer, and engineer.

Section 2

Elections shall be held at the first meeting in October.

Article 8. Amendments

Section 1

Amendments may be made to this constitution by a three-quarters vote of the club.

Many science clubs use what is known as the "point system." This is a sort of incentive for a member to compete with the others in the club in appearing on the club program. Each activity (demonstration, report, etc.) is assigned a certain point value, depending on its difficulty; and the persons amassing the greatest number of points win prizes. We have discovered that a member's desire to win the approval of his fellow students by his appearing on the program is a sufficiently strong incentive, and we have never used the point system. Furthermore, one of the conditions imposed upon a newly admitted member is that he be willing to appear on the club program frequently; and we therefore rarely lack interesting material for our meetings.

Some of the outstanding features on the program of the Lincoln School Science Club during the past year have been the following:

A lecture demonstration on liquid air. About two quarts of this were secured from the chemistry department at Columbia University, and with it a variety of phenomena were illustrated. Rubber was cooled to such a low temperature that it became as brittle as glass, mercury was frozen, chlorine gas was liquefied and then solidified. Glowing charcoal was plunged beneath the surface of the liquid air and burned vigorously. Cotton was soaked in the liquid oxygen which remained after the nitrogen had evaporated and became as explosive as guncotton. Corks were popped from bottles and toy steam engines were run by the pressure produced by the ever-boiling liquid.

A series of chemical experiments. (Chemical experiments form an important part of the programs of most science clubs because of their spectacular nature and the simplicity of the equipment needed for their performance. Interest in them, especially on the part of boys who have "chemcraft" sets is always very keen.) In addition to the demonstration of thermite previously described, there have been presented the following discussions:

1. The manufacture and properties of oxygen
2. Phosphorus, its uses and dangers

3. The instability of certain nitrogen compounds—particularly nitrogen iodide and guncotton
4. The manufacture of gas from the destructive distillation of wood and coal
5. How colored inks are made
6. The preparation of artificial smoke

Demonstrations in the field of electricity, particularly in connection with alternating currents and electro-magnetic induction. These included lighting an electric lamp through a piece of glass, strongly repelling rings made of nonmagnetic metals, rotating disks by inducing currents in them, etc. Many of the demonstrations, of course, consist of the exhibition of some piece of apparatus which a youngster has constructed —a motor, a radio transmitter, or an electric cannon.

Motion pictures on science topics—the operation of the four-cycle gasoline engine, the nature of life, etc. The many excellent science motion pictures now in existence, and which can be obtained from museums and industrial concerns, make excellent material for science-club programs.

Other ideas for programs are contained in the two articles previously referred to.

In brief, then, the science club is a source of worth-while enjoyment, both to those who participate in its activities and to the teacher who guides its course, and it leads to increased coöperation between the teacher of science and his pupils.

THE PRACTICABILITY OF SCIENCE COURSES OF STUDY IN THE INITIAL SECONDARY YEARS (SEVENTH AND EIGHTH) IN 8-4 AS WELL AS IN 6-3-3 AND 6-6 SYSTEMS

W. L. SPENCER

EDITOR'S NOTE: *Mr. Spencer is the director of secondary education in the Alabama State Department of Education. His ten years of service in this position have resulted in a development of junior-senior high schools in Alabama which gives this State first place among all States in the ratio of reorganized schools to total high schools. Mr. Spencer's philosophy is summed up in this statement in his article: "The development of the junior high school is important for the city child, but for the rural child it is vital."* J. M. G.

The importance of a general study of science for adolescent boys and girls has been shown in the papers preceding this one. Before the years of compulsory attendance are passed every normal boy and girl should study his surroundings in their relation to science, and should have the interest in his environment and appreciation of it which a suitable scientific approach brings. The purposes of exploration and orientation should be major ones in all junior-high-school work; in science these are of peculiar significance, since this subject bears so pointedly at the adolescent age on the seven objectives set up by the Cardinal Principles, particularly on the exploring and orientating features of these objectives. There seems to be considerable evidence that much of the value of general science is lost if it does not come before the ninth grade. Many of the systems I have had the opportunity to observe recently have made general science a constant subject for the seventh and eighth grades; in some cases it is given in the ninth as well as in the seventh and eighth. Real difficulty has arisen when courses planned for the ninth grade are attempted in the seventh grade and vice versa. This obstacle is not a necessary one, however, and our textbook

makers are doing their part to eliminate it. Further knowledge of the nature, interests, and needs of adolescent boys and girls will soon be available to guide more satisfactorily in the allocation to the individual grades of the various problems in general science, but there seems to be an abundance of evidence that general science should begin in the seventh grade. Most junior high schools have already adopted this practice. Should not children in school systems which include grades seven and eight in the elementary school offer these advantages to the adolescent youth just as this is done in the junior high schools? This paper is concerned with the practicability of such procedure.

Some school systems have already adopted this plan and frequently have met with satisfactory results. Where the seventh and eighth grades have been departmentalized it has been possible to have almost as satisfactory outcomes for the study as in the junior high school. This, of course, suggests a great difficulty which is met when the general science is taught in grades seven and eight in the elementary school. Unless a system is large enough to make departmentalization possible or to have teachers for these grades who have had special preparation and have been given special apparatus and equipment, the difficulty becomes almost insuperable. Such a plan generally has been limited to the larger city school systems or to large consolidated schools.

Although the difficulties arising from the need of apparatus are not so hard to overcome, a very serious one comes up in connection with the training of teachers. Few elementary teachers are properly prepared to handle classes of this sort. Not all of our teacher-training institutions for elementary schools have realized and accepted responsibility for preparation of teachers for effective work in general science. In fact, the nature study offered in the lower grades is suffering from this same difficulty. No doubt this could be corrected if general science were universally established as a required subject for the seventh and eighth grades. Again, city school systems may undertake plans which have not seemed practicable in rural systems, except, of course, in the large consolidated schools.

It has been found difficult in some schools to find a place for general science in the program of studies for grades seven and eight. Of course, this means that less consideration and appreciation are given to the values of general science. It is no easier to place science in grades seven and eight in a junior high school than in an elementary school, but the reconsideration of values attending the introduction of the junior high school has generally forced science into the program. The same traditions and prejudices that oppose the introduction of the junior high school are likely to obstruct the introduction of general science into these grades in the elementary schools. Probably the greatest difficulty in promoting science in grades seven and eight of the elementary school will be found here.

Until rural schools are consolidated, it will be hard to do much in general science in them. As soon as an elementary school in the country has five or more teachers some science work can be undertaken, but eight teachers will be needed to give a convincing guarantee of the proper training and specialization for teachers and to justify the desirable departmentalization. Science, however, is not the only field in which children who must attend the small rural school are handicapped. Centralization of the schools in the country is absolutely necessary before educational opportunities can begin to approach equalization for rural and city children. The development of the junior high school is important for the city child, but for the rural child it is vital. From several points of consideration the

rural junior high school is much more sadly needed than the one in the city.

SUMMARY

It is easier to organize a satisfactory program in science in the junior high school than in those systems which include grades seven and eight in the elementary school. However, fairness to pupils seems to demand that provision for science study be made for boys and girls of the adolescent age, whether the junior-high-school organization has been set up or not. City high schools will find it practicable to set up acceptable courses of general science in grades seven and eight, even when they are grouped with the elementary grades. Specialization of teachers and departmentalization of classes will be a great aid. Programs for the training of elementary teachers should be revised and adapted to meet satisfactorily this demand on elementary teachers. Science should be granted a place in the program which makes possible the necessary excursions, demonstrations, experiments, projects, and the like. Larger consolidated rural schools can be adapted to this program nearly as well as city schools. Small rural elementary schools which include grades seven and eight will find significant work in science very difficult, in some cases impossible. Other subjects as well as science are at a serious disadvantage in small rural schools. A radical program of centralization of rural schools must be carried out before country children can receive an equal chance with the city child.

SOME ASPECTS OF THE GENERAL SCIENCE SITUATION

OTIS W. CALDWELL

EDITOR'S NOTE: *Professor Otis W. Caldwell is director of the Institute of School Experimentation, at Teachers College, Columbia University. He was the organizer and director for its first ten years of the Lincoln School of Teachers College. He was formerly professor of the teaching of natural sciences in the University of Chicago, and dean of University College of the University of Chicago. He is chairman of the American Association for the Advancement of Science Committee on the Place of Science in Education. This Committee now has in hand an extensive coöperative study with secondary schools.*

J. A. D.

It was a little more than twenty years ago that the first courses in general science appeared in secondary schools. These early courses differed widely from one another in content, purpose, and method. They differed in the high-school year in which they were offered. In some of them each of several science teachers took a part of the course, each one teaching his own special subject for a period. In others a single teacher taught the whole course and tried to unify his materials into a more or less coherent whole. Sometimes a special-science teacher taught the general-science course, using his special subject as his main foundation, and bringing in some materials from other science subjects.

Quite early in the general-science curriculum movement, topical unity began to appear. Special-subject organization declined, although special-subject methods were more slow to give way to methods appropriate to the new organization of material. The junior-high-school movement had not started, and standards of curriculum development had not taken even the amount of form which they now have. In a sense, therefore, the general-science movement was one of the first steps in the reorganization of the modern secondary cur-

riculum. It antedates organized curriculum committees and commissions. It was partly the cause of efforts towards curriculum reorganization in other subjects of study.

General science developed with astonishing rapidity. It appeared on school programs all over the country. It soon became chiefly restricted to the first year of the four-year high school, and under these conditions began to be a subject of interest to those who dealt with college-entrance requirements. In some States, during the first ten years of general-science teaching no college-entrance recognition was allowed the subject, while in others it was credited by certain colleges in case the high school itself listed the subject as one being credited towards the high-school diploma. In other cases the subject was not given college-entrance credit unless laboratory instruction in doubled laboratory periods was a feature of the work in the course. In still other cases detailed course outlines and prescribed examinations were made the basis of credit for college entrance.

So insistent had the question of college-entrance credit become after ten years of general-science teaching that a study was made to determine to what extent credit was allowed. This study[1] was based upon a sampling of the practices in type institutions in each State of the Union. This work was done in coöperation with H. A. Carpenter, Irene Jameson, Martha Shea, and Ellen Woodyard. Of the 116 collegiate institutions reporting, 99 gave entrance credit in some form for general science. In some of these colleges if a high school's work had been inspected and approved as a whole, any subject taught within that high school was accredited. In others, the credit for a subject was specifically allowed or specifically disapproved. It is evident from the figures given that in the colleges used as samples in the study of 1920, general science was being widely credited for college entrance. No recent study of that type has been made, thus numerical comparison is not now possible. Other factors have entered to change the situation. The junior high school has had its whole development since general science appeared as a separate subject in secondary schools. With the development of junior high schools the seventh and eighth school years have gradually become the years in which subjects of a general nature are introduced and general science is now frequently taught in those years. Then, in the territory included in the North Central Association of Colleges and Secondary Schools college entrance, if the school wishes, may be restricted to the twelve units of work of the last three years of secondary school. By this means general science and any other junior-high-school subject no longer is affected by specific college-entrance requirements. Under such conditions studies of college entrance as related to general science would no longer have significance in the North Central area, since the colleges have left the question of the junior-high-school curriculum wholly to those concerned with junior high schools. Therefore, the present status of the subject may be sought through other studies.

Pruitt[2] examined the courses of study for 42 States. Of these 11 required general science, and 41 recommended it. Forty-one provided some kind of outline or content recommendation for the course. Of the 41 reporting 33 state the objectives which were commonly expected from general-science teaching. Mr. Pruitt states the conclusion that: "There seems to be a tendency to place general science in the seventh and eighth grades and make it a required course." Mr. Pruitt's data show that notwithstanding the tendency just stated, the subject is still most commonly found in the ninth grade. The recent collection of State

[1] Otis W. Caldwell, "General Science as a College Entrance Subject," *General Science Quarterly*, IV, pp. 460-465, 1920.

[2] Clarence M. Pruitt, "Status of General Science as Revealed Through State and City Courses of Study," *General Science Quarterly*, XII, pp. 367-381, 1928.

courses of study and of letters from State educational officials support the findings of Mr. Pruitt's study and indicate still more definite tendencies towards universal use of the general-science course. In Pennsylvania general science appears as the foundational science in practically all high schools. In addition all students must have one unit of a laboratory science (biology, physics, or chemistry) in order to receive the State high-school certificate, but general science "would not be accepted as fulfilling the requirement of one year of a laboratory science." New Jersey "approves high-school courses in general science and general biology and looks to the high schools to see to it that pupils preparing for colleges which do not give credit for these subjects are guided in such a way as to meet the requirements of the colleges for which they are preparing." In Massachusetts colleges "with one exception, are private institutions which determine their own admission requirements." In Maryland the "State Board gives credit for one unit each for general science, general biology, physics, and chemistry, provided they are taught in the ninth grade of the junior high school or in the ninth, tenth, eleventh, and twelfth grades of a senior high school." In West Virginia "general science is required of all pupils in the ninth grade, and biology is required in the tenth grade." In Alabama the State plan advises that general science be taught in the first and second years of the junior high school, three periods a week for two years. The College Association has agreed to count general science given in this way for one-half unit of college entrance." Georgia allows one full unit for general science when seven periods per week are given to the subject. In New Hampshire "general science and general biology have a credit basis equivalent to a single year of physics, chemistry, or physiography. In these two subjects, a year's course may be given and a unit of credit received." In Connecticut, "general science and general biology, a unit each, would be accepted as among the fifteen units required for admission to a State normal school." In New York a recent provision by the State Education Department gives one unit of credit for general science when taught in the ninth grade, when the subject is followed by a full unit in another science. The provisions in this New York enactment are designed to secure a coherent and progressive sequence of science study and as such are especially important, forward looking, and commendable.

From the above quotations taken as samples of the whole situation, it is clear that practices vary, but that when taught in the ninth grade general science usually receives credit towards college entrance. Different private colleges have varying practices relative to the subject. In general State departments of education recommend the subject and give credit for it. If colleges would accept twelve entrance units taught in the last three high-school years, and leave the seventh, eighth, and ninth grades free to develop a coherent and productive educational program independent of college questions, general science, like other junior-high-school subjects, might rapidly be improved.

THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

W. L. Eikenberry

Editor's Note: *Professor Eikenberry has been an active force in science teaching over a period of years. He is the author of several well-known science textbooks and laboratory manuals. Following several years of experience at the University of Chicago High School he has devoted his time to the training of science teachers in the East Stroudsburg, Pennsylvania, State Teachers College and at Trenton, New Jersey, Normal School. For the past two years he has been the efficient president of the National Association for Research in Science Teaching.*

C. J. P.

It has been obvious for some years that considerable research was being done upon the problems of science teaching. It was equally clear that this research was not making an adequate impression upon the science teachers and administrative officers of the country. It was also believed by many that research in this field was not being developed to the extent that should be possible under favorable conditions. Science teachers should turn to educational research with ease. They are usually familiar with the importance of research and with its method as carried on in the field of science. It is relatively easy to apply this interest and knowledge to the investigation of educational problems in relation to science teaching.

The development of research in this field has suffered from lack of opportunity to present the results before a society composed primarily of similar investigators. There have been plenty of societies, but none that offered a suitable forum for the discussion of research in science teaching. Investigations of this sort have therefore been presented either before general educational research organizations whose members had no especial interest in science or before semipopular organizations of science teachers who were little interested in research. Publication was equally unsatisfactory, since papers were necessarily scattered through a good many educational journals, many of which were not readily accessible to science teachers. The net result was that a very respectable body of work was accomplished without making a very notable impression upon the science program of studies in the schools.

The National Association for Research in Science Teaching was organized to meet the needs outlined above. It had its beginning as an organization at a meeting held in Cambridge during the sessions of the Department of Superintendence at Boston in 1928. The policy then adopted was one of slow but solid growth. It is the expectation that the entire membership shall be really active and therefore there has been no attempt greatly to increase the membership during the formative period. It is not probable that the enrollment will ever be very large, but it is hoped ultimately to include every one who is active in the field which the organization covers. Because of its somewhat limited membership, the Association for Research in Science Teaching will never compete for enrollment with other organizations of science teachers.

The two meetings already held have been marked by the attendance of the majority of the members of the Association. If any one entertained any doubt as to whether a society of less than fifty science teachers could produce a sufficient number of research papers to fill a program, those doubts have now been dissolved. A single program session was held at Cleveland and it was necessary to prepare mimeographed ab-

stracts of a number of excellent papers that could not be accommodated on the program. There were two sessions for the reading of papers at Atlantic City and both were similarly crowded. The work of the secretary has not been that of seeking papers, but rather that of finding room for those offered. It is now clear that there is a notable and increasing activity in the field of research in science teaching.

The program meetings of the Association are open to the public. It is hoped that science teachers, supervisors, and administrative officers, whether members of the Association or not, will continue to attend the meetings and to take part in the discussions.

Publication has been provided for by arrangement with *General Science Quarterly*, now renamed *Science Education*, which is under the editorial management of the Association and is in effect its organ. The magazine is open to all, whether members of the Association or not. It welcomes contributions from all sources. *Science Education* is at present the only publication in this country that deliberately sets itself to present investigations in all phases of science teaching in all grades from the kindergarten to the college.

The purpose of the Association is expressed when it is said that it desires to coöperate with every effort looking towards the improvement of science teaching and particularly with all efforts to disclose the factual basis upon which the science of science teaching must be based. Certainly the formation of an organization of this character marks a step forward in the progress of science teaching. Just what will be accomplished in the end depends upon both the members of the organization and those who are not members. The progress of society depends in the first place upon the investigators who uncover truths and secondly upon the inventors, engineers, and others who apply those truths to meeting human needs. In like fashion the accomplishment of the Association depends in part upon the diligence, intelligence, and scientific accuracy of its members in carrying on investigations, and in part upon the work of thousands of classroom teachers who may not be interested in carrying on investigations but whose application in the classroom of the results of investigations constitute a great court of last resort in which the value of those results is determined.

THE POSSIBLE INFLUENCE OF GENERAL SCIENCE UPON THE SPECIAL SCIENCES OF THE SENIOR HIGH SCHOOL

CHARLES J. PIEPER

EDITOR'S NOTE: *Mr. Pieper, who is head of the department of the teaching of science in the School of Education of New York University, was formerly head of the department of natural science in the high schools of the University of Minnesota and the University of Chicago, respectively. He is also an associate editor of the* CLEARING HOUSE. F. E. L.

There have been throughout our country widely divergent views concerning the influences of general science upon the special sciences of the senior high school. The enthusiasts for general science have made exorbitant claims for their "subject," not taking into consideration the administrative and curricular demands which are imposed upon pupils as they pass through the senior high school and "prepare for college." On the other side, the enthusiasts for the special sciences have frowned upon this newcomer and have predicted for pupils pursuing general science a waste of time in their educational progress. One group maintains that general science whets the appetite for more

science, ensures a greater number of elections in the special sciences, forecasts greater accomplishment in later science courses, and above all gives to adolescent pupils the only opportunity many will have to acquire an acquaintance with science and a taste for more; the other group maintains that general science will dull the appetite for more science, will limit the number of elections in the special sciences, will lower the interest and the accomplishment in later science courses, and, because of its unscientific standards, content, and organization, will allow pupils to complete the science requirement without having pursued a truly scientific subject.

The writer recalls one experience which will give a fair picture of the opposing attitudes of enthusiasts and those with vested interests. The experience came in connection with the introduction of general science into the junior-high-school division of the public schools in a large city. No sooner had the committee on junior-high-school science met to consider means of formulating a program of studies than there came from the biology teachers in the senior high school an urgent demand for a conference. The conference was arranged and the writer, having outlined briefly the proposed junior-high-school science program, was besieged with criticisms which indicated clearly that a group of biology teachers was determined not to have their "sacred ground" trespassed upon nor their "subject" modified in any way, no matter what values the proposals for reorganization all along the line might contribute to a program of science education. They were "ready to fight this new subject." Two conferences brought the two groups together into committee work and there emerged from the considerations a general-science course and a biology course properly integrated, each having the support of both groups.

There is little objective, experimental data to be mustered in support of this or that view concerning the effect of general science upon the special sciences. This being true it becomes necessary to speak largely from experience and from the point of view of modern educational practices and trends until such time as objective evidence is at hand. This is doubly true because there exists a great variety of content, methods of instruction and schemes of organization both in general science and in the special sciences, thus making opinions based upon experiences subject to wide variation.

Of one thing we may feel quite certain—a valid course in general science will explore for the pupil the fields of science and lead to more intelligent election of special sciences by the pupil. This does not mean more elections in special sciences as predicted by many advocates of general science, but rather wiser elections prompted by individual interests and abilities. There are enough objective studies to show conclusively that specific abilities, aptitudes, and interests are the fundamental elements which predict success in a given subject and are safe bases for homogeneous grouping. If, then, these may be discovered by pupils and teachers in general science, the elections in special sciences may be made more intelligently. This more intelligent election of special sciences must result in a higher capacity and a greater accomplishment on the part of the pupils if the various courses are properly articulated and integrated.

A second influence of general science upon special sciences is found in the background of experiences and abilities which pupils bring as a basis for the study of the special science. Pupils who complete general science in the junior high school or in the ninth grade have, even though we consider general science at its worst a residuum of terminology, concepts and insights into methods of scientific thinking which must be taken into consideration by the special science teacher. Tests show this residuum

Examination of general-science courses reveals pupils' experiences with a great variety of learning activities which are among the elements of scientific procedure. Several investigators have shown pupil growth in terminology, in powers of discrimination and interpretation, in ability to analyze problems, in ability to interpret drawings, tables, and the printed page, in understanding of science concepts, and in ability to solve problems and organize their knowledge. It should require no argument to prove to open-minded science teachers and school administrators that the pupil who has completed general science is different from the pupil who comes to the special-science courses without a background of introductory science. This being true the special-science teacher must not fail to adjust his course to the abilities of the pupils who pursue it.

A third influence of general science upon the special sciences is already in force and will continue to exert itself. All who have carefully examined the content of general-science and special-science courses are agreed on the existence of a considerable overlapping in content. Leker[1] found that the per cents of the average special-science subjects covered by the average general-science texts are as follows: Physics—41.4, Biology—34.5, Physical Geography—28.7, Zoölogy—7.7, Chemistry—25.0, Physiology—20.5, Botany—17.3. This overlapping and the present security of general science as an introductory science course make it imperative that the content of the sciences be re-selected to ensure a better articulated program of science instruction. Such re-selection is already under way in progressive schools. In one school with which the writer was connected for a number of years and where all science teachers made a careful study of overlapping of junior-high-school science with the special sciences, it was found that from one third to one sixth of the content of the different special sciences was understood by those pupils who after having pursued the general-science course came to the special-science course.

A fourth influence of general science on the special sciences is in evidence in many centers. This concerns the organization of the content and the techniques of instruction and is, in a sense, the sequel of the previously mentioned influences. As early as 1920, the Commission on Reorganization of Secondary Education[2] urged the reorganization of all sciences in secondary schools. The point of view taken by the committee is expressed in the following quotation from page 16 of the report:

> Science for high-school students has been too largely organized for the purpose of giving information and training in each of the sciences, the material being arranged in accordance with the logical sequence recognized by special students of that science. The theory sought justification in the claim that the secondary course is introductory to more advanced study, and as such should introduce the student to each of the leading phases of the subject; furthermore, since special students in each of the sciences have discovered or developed systems of organizing those materials, it was held that the beginner should be given the fundamentals of this system of organization.
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> Neither in common life activities nor in research is the artificial stratification of the sciences maintained in solving problems. Not only is science organized and tested knowledge which in the process of testing has become highly classified, but true science includes the process of organizing, testing, and determining the effectiveness of knowledge. The common method of science teaching too often has been that of presenting the so-called essentials with their definitions and classifications and of subordinating or omitting the commonplace manifestations of science in home, community, civic, and industrial situations which make it most easily possible for the learner to practice science.

Reorganization along these lines has been going on in schools, especially where the director or supervisor of science instruction sees the program of science as a whole

[1] W. R. Leker, "The Articulation of General Science With the Special Sciences," *School Science and Mathematics*, 25:724-737, October, 1925.

[2] U. S. Bureau of Education, Bulletin, 1920, No. 26, "Reorganization of Science in Secondary Schools."

rather than as a series of special interests, and recognizes that the special sciences have been formal textbook and laboratory manual courses lacking to a greater or lesser degree in their purpose to develop the scientific attitudes and scientific methods of thinking in problem situations. In this particular the spirit and method of general science coupled with its success has become a potent influence calling for the reorganization of the special sciences.

All of these influences, along with the trends towards more careful articulation of the work at various grade levels and with the trends towards an integrated program of science from the kindergarten to the end of the secondary level, demand a thorough investigation of both general science and the special sciences. It is safe to assert that an introductory science course will continue to be offered during the junior-high-school grades. The success of such course is evidence of its favor for the present at least. This fact makes it imperative that the special-science teacher must build his course, both in content and in techniques of learning, upon the foundation which the pupil brings. The formal, traditional, *memoriter* type of special science must go and in its place there must grow a type of course which seeks to solve problems in the special-science field, problems of significance to life situations and so studied that pupils will continue to grow in desirable scientific attitudes and methods of thinking and, above all, in scientific behaviors in a democratic society.

In summary, there have been stated four significant influences of general science upon the special sciences. The first two of these are primarily concerned with the pupil; the third and fourth relate more specifically to the science subjects.

1. The more intelligent elections of the special sciences by pupils must lead to a higher degree of attainment in the special sciences,

2. The background of experiences and acquired abilities of pupils who have pursued general-science demands, in terms of an integrated program, a special-science course which is built upon what has gone before,

3. The overlapping of content in general science and in special sciences requires a re-selection of content in the special sciences, as well as in general science,

4. The success of general science and its plan of organization and techniques suggests a careful consideration of a different approach in special-science subjects.

In all of these influences there is the demand that both special-science and general-science teachers enter upon a series of investigations which will lead to an integrated program of science teaching. The burden of proof rests upon both groups.

FIFTEEN YEARS OF EXPERIENCE IN DEVELOPING A SCIENCE COURSE OF STUDY FOR THE JUNIOR HIGH SCHOOL

HARRY A. CARPENTER

EDITOR'S NOTE: *Mr. Carpenter occupies the position of specialist in science for the school system of Rochester, N. Y. For twenty-five years he has given constructive leadership to science-curriculum building in his own city and State. His article tells the fascinating story of his pioneering in junior-high-school science. His vision leaps ahead to a science sequence in elementary and secondary schools. "What an inspiring and glorious future awaits the young science teacher of today." They will follow in the trail of our contributor who has been, is, and always will be a fellow teacher.*

J. M. G

PREPARATION

A discussion of fifteen years' experience with the development of a three-year course in general science for junior high schools must of necessity be limited to a few of the more significant and interesting events. The material in this article is taken largely from published and unpublished papers, studies, and correspondence of the writer, and from the minutes of meetings of the Junior High School Council.

While many of the problems involved were peculiar to Rochester, we profited greatly from the experiences and judgments of others. Especially are we indebted to the inspiration of Dr. John F. Woodhull, one of the first to point the way towards the emancipation of science, and for the direct help and advice of such men as Dr. Otis W. Caldwell of Teachers College and Professor Clarence F. Hale of the New York State College for Teachers.

Still more closely associated with the writer are the Rochester teachers whose advice, encouragement, and untiring efforts have made the development successful. The progress of general science in Rochester has been steady and directly due to the enthusiastic coöperation of all teachers concerned and especially to the farseeing judgment of our Superintendent, H. S. Weet, his first junior-high principal James M. Glass, the other junior-high-school principals, and directors. It is a fitting tribute to the motto of Rochester's first junior high school—the Washington Junior High School—"Do in Coöperation."

When in the summer of 1914 the Superintendent of Schools assigned the writer the opportunity and responsibility for developing a course in general science he asked: "What do you think should be the aims of a course in general science?" and himself answered, "The training of pupils—not the teaching of a subject." He continued, "Your major interest is chemistry. Be careful not to shape the course as elementary chemistry." And finally, "Is there a textbook?" There were textbooks by Barber, Clarke, Snyder, Caldwell and Eikenberry, and others, which lightened our labors. There was, however, no text which we were willing to accept as a basic text since all were planned for a one-year course in the senior high school.

The fall semester of 1914 was one of suppressed excitement in Rochester educational circles. The unbelievable had happened; a great war had started and the thoughts of teachers were more than ever directed to the opportunities of education, indeed the challenge to education. Hence the period was one of extraordinarily serious planning for all educational units in general, and specifically for the new experiment about to be tried in our city—the junior high school.

The Superintendent of Schools had made a thorough study of the junior high schools throughout the country, and among other

principles conceived by him was the fundamental need for the development of a curriculum designed and specified to function in this new unit of public education and to promote its special objectives. It involved changes far more fundamental than the mere demoting and spreading out of traditional first-year senior-high-school subjects. The development of a science course for the new junior high school must be based upon a thorough understanding of the child, his interests, his everyday problems, and his health needs. Thus the child himself and his immediate environment were indicated as the source of content.

During the spring semester of 1915, under the direction of senior-high-school department heads, weekly meetings were held with experienced seventh- and eighth-grade teachers of the system, who had expressed an interest in the various lines of study to be included in the junior high school. Twenty or more teachers interested in science met with the writer to determine tentatively the objectives, content, and method of the new science course.

We took as our fundamental premise the statement of the Superintendent that our function was to "train pupils—not to teach a subject," and endeavored to shape content and method accordingly. This was not a new idea. However, it is probably correct to say that in 1915 and for several years thereafter the major concern of many teachers of the special sciences was to teach the subject and prepare pupils for an examination. We were to train pupils for living.

There were no criteria for the scientific determination of teaching methods, or content. The method indicated by authors of texts, advice from leaders in the field, and our own judgments involved a combination laboratory-recitation period rather than the traditional special laboratory and recitation days of the special sciences. Realism is necessary for children of the junior-high-school age.

Theoretical consideration and special-science tradition pointed to the need for individual experimentation by pupils. However, the class size, the number of classes per teacher, and the age of the pupils made the application of individual pupil experimentation impracticable to a large extent. Believing, however, that children learn by doing, our method included a large percentage of pupil activity as opposed to the traditional lesson assignments and cook-book laboratory directions.

The tentative selection of content was puzzling. The content defined by available textbooks emphasized one or more of the special-science fields, representing perhaps the special interests of the author. A comparative study of various texts disclosed an absence of any fundamental similarity. Some of the textbooks in general science differed from the traditional special-science texts in that they showed a deliberate attempt upon the part of the author to provide for the development of pupil interest and a content adapted to the pupil's capacity for thinking.

The equipment problem could be answered only on the basis of years of trial. At first tables accommodating four students each were tried, supplemented by a work bench with water and gas on the window side of the rooms. These tables were soon replaced by individual chairs, each with its own work top. Besides projection equipment for lantern slides and opaque objects, only the simplest apparatus and materials were provided.

A DECADE OF INITIAL EXPERIMENTATION, SEPTEMBER 1915-JUNE 1925

The Washington Junior High School was opened in September 1915 with an enrollment of 945 pupils. There were two science teachers on the staff. Now the school enrollment is 1929 and the science work is directed by eight teachers. Today all junior and senior high schools in the city except

one senior school include general science in their program. In the junior high schools it is required of all pupils of the seventh, eighth, and ninth grades. The total number of pupils enrolled in general science is nearly 8000, directed by 46 science teachers.

The first year the school day consisted of four 90-minute periods. The allotment for science was two 90-minute periods per week in the seventh grade and three 90-minute periods per week in the ninth grade, no science being offered to eighth-grade pupils. In 1916 the science time allotment was changed to two 45-minute periods per week throughout both the seventh and eighth years, and three 90-minute periods per week throughout the ninth year.

By action of the Junior High School Council the organization of the junior high school was changed from time to time as experience pointed the need. School periods of 90 minutes were reduced to 80 minutes in length. In 1922 the school organization was changed to a six-period day of 60 minutes each and the allotment for science became two 60-minute periods per week throughout the seventh and eighth grades and four 60-minute periods throughout the ninth grade. Inspection of the minutes of the Junior High School Council shows that with every change in the organization of the school the proportionate time allotment for general science was maintained or increased. This fact is evidence of the value attached to science work for children by members of the Junior High School Council.

The textbook problem was met by supplying, on a rental basis, a number of selected texts in sets for each science room. With the course of study as a guide the teachers presented their work to the students in the form of problems, the solution of which involved laboratory work, individual or demonstration, directed observation, trips, and the use of books as sources of data. At no time during the fifteen years of development has learning from a text been favored as a main objective; rather has the effort been to provide purposeful activities and problematic situations as the mediums for pupil training.

The plan of directed observational work developed gradually but persistently through the years with the belief that pupils of junior-high age must be provided with incentives to make intelligent contacts.

During the decade one of the many problems presented for solution was the consideration of specialized science for industrial-arts boys and a still different type for household-arts girls. Our conclusion has been that if the science content is properly selected and properly motivated in terms of special interests of the special pupil it will be equally suitable and fundamental for the boys and girls in the various courses. The application of science principles or concepts developed as a core will be determined by the special fields of interest. It has not seemed wise, for example, to assume that the industrial-arts boy should be limited in his outdoor contacts because his choice of vocation may lead to an indoor life, or that girls because they may become housewives should be deprived of equal training and development of interests. That all science teaching should contribute to the health objective is axiomatic.

The problem of determination of content and teaching methods, uppermost in our minds at the start, continues to be our fundamental problem today. As to certain fundamental objectives we have been consistent. An article[1] by the writer stated our objectives as follows:

1. To develop the pupil's powers of observation and his awareness of surroundings, and so add to his experiences
2. To help pupils gain simple, accurate concepts
3. To help pupils to an understanding of the common phenomena of their immediate environment

[1] *General Science Quarterly*, November, 1917.

4. To train pupils to be able to apply the experiences and concepts acquired to the solution of new problems
5. To train pupils in the scientific method of procedure and study
6. To establish habitual scientific attitudes

Further, the article calls attention to the fact that the science work "is made to serve as a vehicle for moral instruction; throughout all the courses the home, street, school, and city environment as contributing to the physical, mental, and moral development of the pupil is made the keynote of the science study."

The brief content outline, as published in the same volume of *General Science Quarterly* (now *Science Education*), altered and developed as experience and research has pointed the way, has had a significant influence on the final organization of the syllabus in general science for the State of New York.

Many studies have been made to determine children's interests and to determine how children reacted towards various items in their environment. Questions which they asked, answers which they gave, were tabulated, studied, and conclusions therefrom made use of in revising both content and method. Not only were studies made of children in the junior high school, but similar studies were made in a large senior high school of Rochester. All information obtained was utilized in the study of the problem of content and the problem of integration of junior- and senior-high-school sciences. Similar studies made in other parts of the country have been made use of as they have appeared in print.

While the present methods of research and evaluation of data were not in vogue in the early years of our work, still significant qualitative conclusions were possible. Illustrations of two of the early studies follow:

Two groups of pupils were enrolled for seventh-grade science. One group had had a half year of science and the other group had had no science. A general topic for consideration during a part of the semester was "weather." At the beginning of the term the following questions were submitted to all students of the two groups:

1. What is wind? What can you say regarding differences in winds?
2. What are clouds? How are clouds formed? What causes clouds to move?
3. How do the newspapers get their information concerning the weather?
4. What do you understand by the United States Weather Bureau?

Answers to these questions by pupils of the two groups were tabulated and instruction shaped according to the findings. Neither group had had any special training relating specifically to the topic of weather. The pupils who had a half year of science had had some work relating to rocks, soil, and water. Their directed observational work had included outdoor temperature readings, observation of wind directions, and some observational work relating to the North Star and the Big Dipper, sun, planets, and moon. Typical answers from the group that had had no science are as follows:

Answers to Question No. 1

The wind is a cold draft which comes from water.

Wind is something that mixes with the air. The wind is mostly air.

Wind comes from the clouds and from the trees.

Wind comes from the rain.

Wind is air which is formed by the clouds. The wind is caused by a cold day or sometimes when it is cloudy.

The waves from the sea cause the wind to blow. Causes in the difference of the wind are according to the strength of the waves from the ocean.

Answers to Question No. 2

The moon causes the clouds to move.

Clouds come from smoke.

The clouds come from the east.

The temperature makes the clouds move.

Clouds come from the dust. They consist of dust.

Clouds come from smoke and turn into water in the air.

The thing that causes clouds to move is the earth. When the earth moves around it makes them move.

Clouds consist of darkness.

Answers to Question No. 3

Newspapers receive their information about the weather for the coming day by looking through the telescope up in the air.

The newspapers receive their information from a man that sees the clouds by microscope.

The newspapers receive their information from the man that sleeps in the Samitary (cemetery). They also send something up into the sky that is like electricity.

The newspapers receive their information by going up into the air near the clouds in an airplane.

They put different colors of flags out and find out to what color the flags change and that is the kind of weather that is going to be.

Answers to Question No. 4

The Weather Bureaus are cyclones which blow.

The Weather Bureau consists of a party of men who take sights at the heavens with instruments.

The United States Weather Bureau has a temperate climate.

The United States has so many climates so it is called the Weather Bureau.

The United States Weather Bureau is 40 degrees.

The United States Weather Bureau is where we get our weather from.

Some suggestions made by these pupils not in direct answer to questions are as follows:

Weather changes when the sun and moon changes.

The warm south wind helps the summer plants to grow. The cold north wind helps the winter plants to grow.

Thunderstorms are loud crashes of noise.

Following are some answers given by pupils who had had one semester of general science in seventh grade B:

Answers to Question No. 1

Wind is air in motion (this answer in substance was given by many of the students).

Wind is invisible.

Wind is made up of air.

Wind is consisted of air coming down in great masses and blowing over the earth.

Wind is cold air flying about the earth.

Wind is air made by the earth turning on its axis.

Wind is a thing that blows.

Wind is air.

Wind is a substance that may be cold or hot. It is air that moves faster than the surrounding air.

Wind is a current of air made by the rotation of the earth.

Answers to Question No. 2

Clouds are formed by the evaporation of water from lakes, rivers, oceans, etc.

Clouds consist of moisture and are moved by the wind (the majority of the group gave answers similar to this).

The clouds come from lakes, the sea, oceans, rivers, and streams when the water evaporates it floats as clouds. The wind causes them to move.

Clouds come from the sky. They consist of rain and snow.

Clouds come from smoke and heavy air. The wind causes them to move.

The clouds consist of rain in summer and snow in winter.

Clouds come from the sky. They consist of white messy substance.

On one occasion the writer was asked to entertain all of the seventh- and eighth-grade children of the Washington Junior High School in the assembly room while the ninth-grade pupils and all teachers were on other business. The theme of the illustrated talk had to do with a camping trip in Canada. At the close of the talk the children were asked each to write two questions they would like to have answered. Naturally their questions were influenced somewhat by the talk and pictures, and yet when their questions were organized under topics there were a large number of topics which had no relation to the talk. The several hundred questions were organized under sixty-two topics covering the whole field of the environment, among them were such topics as evolution; biggest, best, and most beautiful birds; eggs; taking pictures; twilight; stars; the earth; the moon; rocks; soil; air; glaciers; fossils; trees; use of science; what is science? how old is science? A few of the questions are:

I would like to know how the world started or when Adam and Eve were born.

Why doesn't the school let the children be out of doors in summer and study nature? I think we could learn more.

How can you tell poison-ivy leaves from other leaves in the woods?

What is the most important thing in science?

Why do we use science?

What is the use of science in business?

Why should we study science in school?

How long ago was it since they began to study science?

Is science found all over?

Who thought of science and when was it declared?

Who was the first one to think of science and how did he happen to think of it?

If people keep using water out of Hemlock Lake, how is it that there is enough for all the people?

Will the world's supply of water ever be exhausted?

In what year did the glacier pass over Rochester?

What causes lightning?

How are thermometers made?

Why is the water in the ocean salty?

What is rock made of?

Where do most rivers start?

What are clouds?

Why doesn't California have any winter season?

How are caves formed underground?

How are mountains formed?

How are hills formed?

Where does the moon get its light?

Why does the moon shine at night?

What is sky and what is it composed of?

What makes the earth revolve?

How many stars are there in heaven?

Why do stars shine at night and not in the day?

What is a fish's skin made of?

How are snakes born?

What is the difference between men and animals?

Which are the most intelligent animals on earth? I am particularly interested in this.

How is it that caterpillars turn into butterflies?

What bird makes the best nest?

What can you do with a bird that has a broken leg?

Why do some birds have speckled eggs?

How do birds get their names?

Do birds have a language of their own?

From the very beginning science clubs have had a high place in our science program and indeed the club idea quickly spread to other departments and has developed to a major activity in the junior high school. Below I quote from an article:[2]

> One noticeable feature in the usual science scheme of today is the lack of opportunity and incentive for a pupil who shows unusual interest or ability in a special field to continue the study of that subject without interruption and at the same time without undue encroachment on the time he should devote to other fields of study.

[2] *General Science Quarterly*, November, 1916.

For example, a boy or girl may early in his science study exhibit unusual activity of thought initiated by elementary study of the stars and planets. In fact I have especially in mind two 7B boys who have shown remarkable aptness for things astronomical. I ask what provision is made by a science plan for boys of this sort to continue the study of this, their hobby? All boys and girls show a liking and ability for some one thing.

What happens in most cases is what I have been forced to say many times in the past. "Yes, yes David, I am glad you like astronomy, and I advise you to read books and when you get to college [if he ever does] you can study more astronomy." What does David do? Just what all the others do, drifts through other interests, farther and farther away from his first real interest and maybe a great astronomer is lost to the world.

Just so far as our science teaching makes no provision for the exceptional pupil to pursue the study of a particular interest, to pursue a hobby, if you will, just so far does our teaching fail.

I feel that the full measure of success of any general-science work in the grades or high school will be obtained only when that science work is supplemented by the carefully organized club plan which will furnish the stepping stones across the streams of other important activities, and allow the boy or girl to give uninterrupted and directed attention to a special interest.

Other problems have had to do with credit for general science by the State Department of Education and its acceptance as a science unit for college entrance. Of still greater importance has been the problem of teacher training. These are still problems. However, the State Department of Education very early gave full credit to the work in science as an alternative with elementary biology. Colleges to which our high-school graduates went also for the most part gave full credit to the work.

Our first teachers were recruited as above described. Later teachers were secured from the senior-high-school field, generally from the smaller high school where they had had experience at one time or another teaching biology, physics, chemistry, and physical geography. Teachers with this experience who had a desire to enter the field of general science and considered it an opportunity for the training of pupils for

from the fetters of tradition, teachers who were interested in educational progress became good general-science teachers. Teachers in service were and are now offered additional educational training through method courses at the University of Rochester and other universities, and by regular, frequent department study conferences.

The training and experience of the present general-science teachers are indicated as follows: The 46 teachers have had a total of 522 years' teaching experience, of which approximately 7.3 per cent represents college teaching, 20.4 per cent elementary-school, 34.7 per cent junior-high-school, and 37.3 per cent senior-high-school teaching experience.

Of the 46 teachers two are normal-school graduates only, each of whom however is a candidate for a bachelor's degree. The other 44 teachers (95.7 per cent), have a bachelor's degree, one teacher has a Ph.D. degree, and one is a candidate for a Ph.D. degree, 10.9 per cent have the master's degree, and 43.5 per cent are candidates for a master's degree.

Successful experiences of one teacher or one group of teachers were immediately made available to all other teachers concerned. Never has there appeared anything less than splendid coöperation. Abstracts of articles or references to especially helpful articles in science magazines, educational journals, and popular magazines were distributed to teachers monthly, material for this monthly bulletin being furnished by the teachers themselves.

One of the innovations made with the building of our second junior high school was the installation of a greenhouse. Later two additional junior high schools were provided with still more satisfactory greenhouse equipment and our newest junior-senior high school, now building, is provided with a very fine plant laboratory, as we are pleased to call it. This development has added to building costs and to the cost of science teaching. Needless to say the plan has been continued and enlarged because of very direct evidence of the value of this kind of science opportunity. Every semester in each school provided with greenhouses, hundreds of pupils are given the opportunity to make things grow—to care for, to protect, and to love. Here indeed the seeds and plants themselves are studied and handled as a substitute for book learning. Space does not admit of more than the briefest mention of this development. In it we have had the coöperation of the Department of Parks and commercial greenhouse men. Literally thousands of city children have become interested in growing things and have communicated that interest to the home. Who can measure the benefit?

STANDARDIZATION AND EVALUATION, 1925-1930

It should not be assumed from this section heading that the first ten-year period did not include some standardization and evaluation. However, new methods in testing, the application of the principles of scientific research in education, greater interest of college-entrance boards and greater concern over the objectives of education in general and science education in particular have contributed to make the last five-year period one of special standardization and evaluation. This five-year period in Rochester has been one of intensive testing, evaluation of objectives and methods, and curriculum revision in all departments.

In 1922 we began the preparation of objective tests in science, data from which were carefully organized, studied, and utilized in adjusting our content and evaluating objectives.

General science as an organized study has become increasingly recognized by colleges and accepted as a science unit. The method of general science throughout the country has influenced the teaching of the special sciences and I believe is destined to

do for the senior high school what general science, in the words of Mr. James M. Glass, written in 1918, has done for the junior high school: "to take the life point of view rather than the academic has been an emancipation proclamation to this school. Your department [science] has been one of the big instruments in emancipating the junior high school from the narrowness of the former course of study."

At the time general science was started in the Washington Junior High School, 116 high schools in Pennsylvania were reported as offering general science.[3] In Michigan 27 per cent of 283 accredited schools were offering general science.[4] In Oregon in 1916, 35 out of 175 schools offered general science. However, so far as the writer is informed, these courses were almost uniformly given in the first year of the four-year high school. Our problem was to provide science as a core subject for children of the three grades of the junior high school, and today this practice is rapidly becoming uniform.

In an article[5] Dr. Otis W. Caldwell said "general science as an introductory science in first-year high school is the most promising of all subjects which we have attempted in facing this new demand in science teaching." How completely the experience of fifteen years has proved the accuracy of his vision! May I add that the inclusion of general science in the three years of the junior high school has become the chief starting point for the development of a twelve-year articulated course in science education.

It is interesting to consider briefly the attention given to the development of general science in the State of New York since this had been intimately associated with the development in Rochester. In November 1917 a committee (H. A. Carpenter, West High School, Rochester, chairman; Guy A. Bailey, Geneseo Normal School, and Byron O. Burgin, Albany High School) made a report on general science to the New York State Science Teachers Association. This committee recommended that general science be offered as a one-year course in the four-year senior high school; or as a two-year course for the eighth and ninth years of the junior high school; or that science be given continuously in the seventh, eighth, and ninth years of the junior high school. The committee further recommended that immediate steps be taken to provide courses in general science for teachers in our normal schools and colleges. The recommendations were approved by the Association and copy sent to the State Department of Education.

In 1917 the State Department of Education appointed a committee (Dr. Herbert S. Weet, Superintendent of Schools, Rochester, chairman) to study and make recommendations for the development of junior high schools in New York State. A subcommittee on science was appointed consisting of Professor Clarence F. Hale, New York State College for Teachers, Albany, and the writer. This committee made recommendations substantially in line with the present general-science syllabus of New York State, as did the committee referred to above.

In 1919 an Educational Congress was held in Albany at the invitation of Dr. John H. Finley, commissioner of education. At this Congress considerable attention was given to the problem "The Place of General Science in the Public School Curriculum." As a result of this meeting a committee consisting of Dr. Otis W. Caldwell, chairman, Dr. James E. Peabody, and Harry A. Carpenter, was appointed in May 1919 to make recommendations concerning general science which was done in July 1919. In December 1919 the New York State Science Teachers Association at the meeting in Albany endorsed the recommen-

[3] *General Science Quarterly*, I, p. 224.
[4] *General Science Quarterly*, II, p. 268.
[5] *General Science Quarterly*, I, p. 136.

dations of Dr. Caldwell's committee particularly with reference to the recommendation "that in the four-year high schools wherever possible there be a course in general science in the first year followed by a course in biology in the second year. Where this two-year sequence is not advisable we recommend that general science be offered in the first year as an alternative with elementary biology with equal credit *in schools where in the judgment of the State Department adequate equipment and experienced, well-trained teachers in general science are available.*" The italicized statement was appended by the Science Association at the recommendation of the committee.

Experiments in the development of general science were going on in a few schools in the upper part of the State and in some schools in New York City, each of which contributed its share to the development of general science in the State.

After so many recommendations to the State Department with respect to the need for fostering general science in the State and after a consideration of the problem by the State Examination Board for two or more years, the Department in 1923 appointed a committee (George C. Wood, head of department of biology and general science, James Monroe High School, New York City; Harry A. Carpenter, specialist in science, Rochester, New York; Annah P. Hazen, head of department of biology, Eastern District High School, Brooklyn; W. Lynn Houseman, principal, White Plains High School; Arthur G. Clement, supervisor of biological and general science, State Department of Education, Albany) to construct the first syllabus in general science for the State of New York. After the acceptance of the State syllabus by the State Examinations Board in December 1925, Regents examinations were first offered in the subject in June 1926. While there appeared to be many reasons why State-wide examinations should not be given in the field of general science, among them their standardizing influence in a field where local interests must be emphasized, still in the opinion of the writer these State examinations have contributed in a very large measure to the success of general science in the State. They have helped to give college-entrance authorities and school administrators a respect for general science that could perhaps have been achieved in no other way.

It is interesting to note the remarkable agreement of the various recommendations over a period of so many years with respect to a science sequence, with the recommendation made to the State Examinations Board in December 1929 and aproved by it, portions of which are quoted below:

> Action by the State Examinations Board should be taken with the welfare of the large majority of pupils in mind.
>
> Changes in the present science program should look towards the preparation of pupils for life in a world where all sciences are increasingly important.
>
> The organization of science courses should look forward to a more articulated and interdependent sequence of courses for all grades in the public-school system.
>
> There is at the present time in the process of preparation a State syllabus in elementary science for the first six years of the elementary school. It is planned that this elementary-science course shall fit in with the seventh-, eighth-, and ninth-grade general-science courses as outlined in the present State syllabus. It is to be hoped that the more advanced secondary-school science courses may in time be so organized in relation to the more elementary courses as to present a closely articulated program in science, extending through all grades of elementary- and secondary-school systems.

The State Examinations Board also approved the writing of a new course in general biology for the tenth grade that should be articulated with the ninth-grade general science. They further approved that general science in the ninth year be considered the basic science of two-year sequences when followed by one of the special sciences.

The unparalleled growth of general science throughout the country in the junior-high grades and in the first year of the four-year senior high school is a tribute to its usefulness in the public-school curriculum.

The need for special training for teachers of general science is keenly recognized today and indeed has been recognized during the whole period of this development. Even in the summer of 1917 at least eight of our large universities and three of our large normal schools offered training courses in general science for teachers. Today an increasing proportion of our colleges for teachers and normal schools are offering special training along these lines and a very large number of academic colleges and universities include similar courses in their summer sessions. Much, however, remains to be done in this field.

A LOOK AHEAD

This fifteen-year period just closing has been momentous for every phase of our national and public life. What teacher in 1915 would have dared suggest that in 1930 almost any boy or girl in the United States who desired to do so could listen to the spoken words of the King of England? Who would have believed that Byrd in an airplane flying over the South Pole could be in almost constant communication with New York?

Changes in educational methods have been inconceivably slow when compared with progress in the achievements of science. Now, however, the method of scientific research is being applied to educational problems and we may expect rapid strides in the future. Is it too much to predict a development in science education that will provide science instruction for every pupil during the course of his elementary- and secondary-school life? What an inspiring opportunity and glorious future awaits the young science teacher of today!

Finally, we quote from our Superintendent speaking to the teachers of Rochester: "If science teaching could increase the pupil's habitual dependence upon facts for the formation of judgments and so produce greater tolerance, the whole cost of science instruction would be justified."

THE DESIGN AND EQUIPMENT OF JUNIOR-HIGH-SCHOOL SCIENCE ROOMS

C. L. CUSHMAN

EDITOR'S NOTE: *Dr. Cushman for the past four years has been director of research in the progressive school system of Oklahoma City. He has brought to his secondary-school leadership (a foremost claim upon him) a wide experience as instructor, administrator, and supervisor in both elementary and secondary schools. Superintendent J. R. Barton and Dr. Cushman are developing a group of junior high schools representative of the best practices in the country. Dr. Cushman's practical suggestions of science-room specifications and equipment are within the power of small as well as large schools. His article reveals clearly the fact that junior science is no more a problem of financing than mathematics, "General science will become a way of living." Secondary education founded upon this philosophy is modern and sound.* J. M. G.

The first thing which must be considered in the purchase of science equipment is the aim or objective of the work. If the primary aim of general science is to have the student study and memorize certain scientific facts, the problem is quite different from what it is if the primary aim is to form certain habits of observation and in

quiry into the things which we see in the world about us. To illustrate this difference, in a certain school system in a small mid-western town there were in two years' time two successive science teachers whose aims in the teaching of science represented the extremes of these two types of aims. The first of these two teachers was much more concerned about the habits and attitudes which his students formed than with the particular information which they acquired. The meager science equipment with which the laboratory was provided was more than adequate for the students of this teacher when it was supplemented with plenty of string, different sizes and kinds of boards and boxes, some parts from an old Ford car, chalk, old bottles, paint cans, etc.

The teacher of the next year was of quite the opposite type. His ambition was to see that his students mastered the text. To assist in achieving that end he requested his superintendent and the board of education to purchase for his use all of the scientific apparatus suggested in the manual which accompanied the text which he used. To achieve his aim this equipment was necessary.

This elaborate equipment was not only not needed by the first teacher but would have been a positive handicap to him. Many strong science teachers have actually been handicapped by having too elaborate science equipment.

The aims of general science which classroom teachers regard as most important were shown by Howe to be: "(1) understanding, appreciation, and control of one's everyday environment; (2) appreciation of the applications of science in industrial and social life; (3) a fund of valuable information about nature and the sciences; (4) training in the use of scientific method in solving problems; and (5) preparation and foundation for later study of special sciences."[1]

The extent to which we will achieve these aims in actual practice will be in large part determined by the type of apparatus and equipment with which science rooms are supplied. Sanderson, the great English schoolmaster who saw in the teaching of science the key to many of the world's most vital problems, in speaking concerning this matter, said:

> How well I remember, years ago, setting out to teach science with an army of cylinders, brass, iron, and deceptive wood, forty boys working in pairs, all doing the same experiment at the same time, squared paper at sixpence per sheet, metric scales to order! Then the instrument makers came and fought with each other in turning out the cheapest "Archimedes set," or in inventing the most expensively elaborate set for rich people; then the schoolmaster came and improved on these, and invented new kinds of Boyle's Law apparatus and patented them, or sent them to the *School World*. Perhaps these things were right thirty years ago. . .
>
> I appeal, therefore, for an escape from the bondage of elementary science and physical measurements; those records have done their work for the present, and a wider sphere awaits us. There must be a return to the Romance of Science.[2]

No other level of instruction in the American schools of today offers possibilities for this "return to the Romance of Science" equal to those of the junior high school. But if this way of return is to be left open there must be no standardization of science equipment for junior high schools. The writer can think of nothing which could be more unfortunate for junior science than the thing which has happened in many senior science rooms where we are often told that new ideas won't work because they won't fit the laboratory equipment.

In the opinion of the writer, the first problem in science equipment is concerned with the science room itself. The room should be of such a size and type as to invite "romantic science." A science room

[1] Clayton M. Howe, "What Eighty Teachers Think as to the Aims and Subject Matter of Science," *General Science Quarterly*, II, pp. 445-458. May, 1918.

[2] *Sanderson of Oundle*, pp. 241, 242.

should certainly be not less than forty feet long, and forty-five feet is not excessive. The width of the room should be the standard classroom width of from twenty to twenty-three feet. Because of the many uses to which the wall space of the room must be put, part of the blackboard of the room may be of the multiple swinging type. This should be placed in the front of the room where it will be well lighted for pupils seated in all parts of the room. A large section of bulletin board, not less than an eight-foot length, should be placed on the side wall opposite the windows where it will be well lighted from all parts of the room. This will provide space for the display of valuable scientific illustrations which are readily available. Bookshelves, providing space for an ultimate room library of four or five hundred volumes, should be built into the room. Some form of cabinet for the display of various types of scientific collections should be built into the room. A display cabinet built into the corridor wall outside of the room is also valuable, in that it will serve the dual purpose of an advertising medium for the department and a place of display for current projects conducted in the class. Such a cabinet discourages permanent collections which too often become dust collectors and are without the value of having been contributed by the current group of students. A large closet or storage cabinet will of course need to be available for the storage of science supplies. Built-in cages for birds, animals, reptiles, and insects, as well as an aquarium will find good use. A south orientation for the science room is desirable. A large bay window lined with nonrustable metal supplies a place for growing plants and experiments in germination. Long narrow plain-top tables, with seats on one side only, provide the most satisfactory means of seating the students. These desks should perhaps be provided with gas and electric connections. If water is available elsewhere in the room, none is needed on the desks. The teacher's desk should be a model demonstration desk.

With such a workroom as this provided for science, and with teachers who have an adequate conception of the importance of their subject, the rightful objectives of junior science, and an abundant supply of initiative, the problem of science equipment becomes relatively unimportant. Raw materials, many of which are available at no cost whatever, will then substitute for elaborate apparatus. Initiative on the part of the students and teachers will be encouraged. The spirit of the pioneer will replace the cut-and-dried method of the classroom lecture. And general science will become a way of living rather than so many laws or bits of scattered information.

As a specific illustration of science work carried on with such improvised apparatus and materials as have been suggested in this article, the following illustration, furnished by Mr. Roy Martin of the science department of the Roosevelt Junior High School of Oklahoma City, is here given. It is, of course, apparent that this illustration is limited to the field of electricity. One can readily see, however, how the same method can be carried into any field of general science.

A motor company gave me an old Ford generator to build the machine described below.

The boys of the class built a frame about the size of a grindstone stand, using scrap lumber.

A Ford rear wheel, old style clincher type, and half of a Ford rear axle were fastened at one end of the frame with two "U" bolts. A small hole was bored through one of the spokes of the wheel near the rim so a handle could be attached with a long stove bolt to propel the machine by hand. A Ford generator was attached at the other end of the frame with "U" bolts, the cog wheel removed from the driving end of the generator and a Ford fanbelt pulley soldered on the spindle where the cog wheel was removed. Two or three pieces of old webbing from a touring-car top were sewed together to make an endless belt. The "U" bolts which held the generator to the frame were loosened so the generator could be slipped towards the drive wheel. The

the belt was slipped over the drive wheel and the generator pulley, and the generator moved away just far enough to make the belt tight enough to turn the generator when the drive wheel was turned. If the belt became too loose it was tightened by moving the generator a little farther away and re-tightening it.

When the drive wheel was turned over once, the generator made about ten revolutions.

The cost of such a machine is practically nothing because any motor company will be glad to give the school used parts which they could not sell, but which will do very well for general-science demonstrations.

What may be taught with this machine?

(1) ***Mechanical Advantage.*** Place a crayon mark on the drive wheel and another on the generator pulley. Then turn the drive wheel over one time slowly and count the generator revolutions.

(2) ***Incandescent Light.*** With a socket and bulb from a Ford reflector (6-8 volt bulb) the machine may be turned until bulb glows and brilliance of bulb noted at various speeds.

(3) ***Electromagnet.*** Wrap wires around soft iron bolt and make a very nice little electromagnet.

(4) ***Electro-Magnetic Field.*** Run wires in N and S direction and hold magnetic compass above, then below, and note the needle is deflected oppositely in the two cases. Ampere's Right Hand Rule may be explained and the current traced back to generator and the positive and negative generator poles identified.

(5) ***Egg-Candler.*** A three-foot piece of two-inch cardboard tubing may be converted into a very satisfactory egg candler by inserting bulb at lower end, cutting notch in side of tube to admit an egg and peeping in at the top of the tube.

(6) ***Study of Generator Parts.*** Students may take generator apart and reassemble it to study the parts.

One can see that several hundred dollars could have been invested in apparatus and materials to be used in covering this same unit of work if purchased from scientific companies. The important thing, however, is not the saving which was made by the method used by Mr. Martin; rather it is in the experience which the boys and girls in his class had in thus devising their own scientific equipment and methods of procedure.

CATERING TO THE INDIVIDUAL

H. L. STAHNKE

EDITOR'S NOTE: *Mr. Stahnke is a teacher in the high school of Mesa, Arizona, and has been doing outstanding work of a progressive nature in biology.*

P. W. L. C.

The American philosophy of education may be summarized in the words, "whosoever will may come." Truly this is a real democratic spirit. No one is barred. All kinds of individuals—from the blackest to the fairest, both from the integumentary and mental aspect, are invited to hasten their experiences. Seemingly there is a place for all in our great democratic educational philosophy.

AN EDUCATIONAL PROCESS

Whosoever will has likewise become the actual invitation of the school. Every one that desires—and even those that protest—is put through some part of the educational process. We are quite liberal in our invitation, but once it has been accepted are we as free to impart knowledge to the individual?

Individuals enter the place of learning, but groups are subjected to the educational process. Whosoever will is now corralled into a subject-titled classroom. This group, throughout the subsequent period, receives a broadside of facts with the privilege of assimilating them if possible. Physiology teaches us that the digestive juices act on particles of food. If we fail to masticate properly, the food bulk is thoroughly digested only on its outer surface. This is very comparable to the old method of teaching. The bright "A" student is fairly well digested, all other things being favorable—the "B" student less so, and so on until the center, "E," of the teaching bulk is

considered. Here digestion has not taken place, and so it is eliminated from that system. This undesirable material is then forced upon another system handling a smaller teaching bulk. Thus from one system to the next goes this poor quality material. Some of it may get partially digested. If not, it is eliminated from the entire educational process. That material which does become partially digested later has the privilege of forming the leadership group for the eliminated number. Thus the American social order is manufactured.

The American philosophy of education calls for a "place for all." School administrators are slowly progressing to the fulfillment of this ideal, and at the same time moving towards a solution to the problem confronting our systems of education. With administrators responding to this idealistic and problematic challenge, it behooves the modern teacher to follow suit.

If individuals have been called to school, individuals should be taught in school. Administrators may group individuals according to their probable intelligence, but this is not ensuring the individual a personal education. It is, in the last analysis, up to the teacher to give this assurance. Certainly there must be methods of teaching the individual without resorting to the enslavement of the private-tutoring process. At this time, the greatest possibilities seem to lie in those methods enlisting the teacher as a guide, rather than as an encyclopedical instructor. The experiment that I have chosen to undertake embodies this idea.

A PREVIEW OF THE METHOD

The teacher in this method will take the attitude of a guide and the students that of explorers. If these two ideals are impressed upon the student, it seems that learning ought to take place more naturally. We learn when led by curiosity, and we learn best when this is an intelligent curiosity. In order to develop curiosity, the teacher must not be too free with his information.

During the semester, through which this experiment will be conducted, each individual will be required to study four large topics in biology. Each of these topics is built around a large biological principle. The objective of each of these four main divisions is threefold: first, to give every member of the class a clear, simple understanding of the principle involved; second, to give advanced work in the application of this principle; third, to give additional advanced work and theoretical reading for a greater understanding and appreciation of the principle. Students of average and below average ability are applicants for the first phase of the objective, while those just above average ability are included in the second phase, and the exceptional student in the third phase. This threefold objective likewise lends itself readily in the giving of a grade for the student's scholastic record.

With this threefold objective in mind, each of the four main topics have been subdivided into three "explorations." The simplest one is designated as the "C" exploration, the next as a "B" exploration, and the farthest advanced as an "A" exploration.

Each individual must complete the "C" exploration of each of the four large topics. The choice of where to begin, when considering the large topics, is left with the individual. All members of the class obviously must begin with a "C" exploration. When he proves that he has mastered the principle, the individual is permitted to go on with advanced explorations, providing it is in keeping with the semester time schedule. Should a student complete "A" work in all topics before the semester ends, he will be privileged to work on original biological research. There is a possibility that his curiosity has not been sufficiently aroused. In this case he will be allowed to

use his time in some other field of study. In order to safeguard against the probability of the student putting too much time on biology, he is required to do work on this subject only during his regular biological class period.

THE METHOD IN DETAIL

In order that the teaching of individuals should be a success, it seems that the individual must be more thoroughly acquainted with himself, than under a group method of teaching. Not only must he be more acquainted with his own abilities, but also with efficient methods of attacking the material to be studied. Deeming these things of great importance, "orientation week" is introduced. During these five days the student is helped in finding himself. His ability to read rapidly, and his ability to comprehend what he reads, are tested. This information is given to him together with the abilities of all the members of the biology classes. He is then given careful oral instructions in methods of study. After this general information each student is specifically tested for his present biological knowledge. The material of this pre-test has the same organization as that of the outline of study for the semester. The test is graded sectionally, thus giving the individual a proper perspective of his present knowledge in these four fields of biology. Following the pre-test, oral instructions are given in the method of learning to be used during the ensuing semester. These instructions are accompanied with brief practices in the method in order to ensure that all the individuals have a thorough understanding of the instructions given. The technical instructions have now been completed, and the week is given its finishing touch with an inspirational lecture. At the close of the lecture mimeographed sheets are given to each member of the class. These sheets contain the oral instructions received during the week together with a study outline.

On the following Monday each individual begins the work of the semester. After he has chosen his field to explore he makes up a daily schedule for the week. Before he may proceed the guide must approve of this schedule. The individual is able to form a fairly accurate schedule, first because he knows his ability to read and comprehend, and secondly because he is given the number of words in each small subtopic to be studied in his study outline.

During the regular procedure of study each individual is required to hand in, on a form provided, a question on the main thought of each small subtopic. This question is to be of such a nature as to give the guide an insight of the individual's comprehension. If the question is not satisfactory it is returned with "shorthand" comments written on it. This subtopic must then be reconsidered. By this method the instructor has a very satisfactory control of the situation.

When the individual has completed his "C" exploration he is required to take a mastery test. He must give the instructor twenty-four hours' notice of his desire. During this time the instructor is able to consider carefully the test requested, and the one making the requisition, time to review. If, when the test has been taken, mastery is not indicated, the student must review until such a time that he feels his understanding of the principle is satisfactory. After sufficient evidence of mastery is given, the student is permitted to advance as previously outlined.

CONCLUSION

From the preceding discussion it should be evident that each student is able to be given individual guidance without overworking the teacher. At the same time, an attempt is made to permit the student to conduct his affairs.

At the time of this writing, the method has been in practice a number of weeks. The usual problem of discipline is remarkably minimized. Whether or not this will continue, of course, remains to be seen. It is inspiring to see the eagerness to gain knowledge that most of the members now display. Individuals with common problems group about the instructor for consultation. As the light bursts upon them, they leave the group to continue with their own exploring. The nasty, humdrum, routine of teaching is not evident.

If a laboratory exercise is to be performed, or a field trip to be made, it is now quite interesting to the individual because it is that individual's problem.

The writer does not wish to appear overenthusiastic as he realizes that environment can produce remarkable changes in a seemingly good hereditary make-up. He is merely groping for some way to teach efficiently the individual.

BOOK REVIEWS

The New Course of Study in Science in New York City.

The new course of study in science for grades seven and eight of the elementary schools of New York City is wide in scope and up-to-date. The course went into effect in February, 1930.

"In its organization of materials of instruction," declares Dr. O'Shea, "the new syllabus stresses those items which occur most frequently. It gives precedence to those activities which permit of objective presentation in the classroom, and it stimulates experimentation on the part of the pupil. Furthermore, it recognizes practical teaching problems by adjusting time allotments, by offering specific suggestions, and by providing for the 'slow' as well as the 'bright' child. The concepts of science are definitely stated in simple declarative sentences. and the ideas leading up to them, as well as a method for the development, are set forth in a concrete and helpful manner. Stressing, as it does, the experimental approach, the new course makes its contribution to that most important objective of science instruction; namely, the scientific habit of mind." A. D. W.

Science and the Way to Health, by J. MACE ANDRESS and MAUD A. BROWN (Ginn and Company).

The authors of ***Science and the Way to Health*** intended to introduce to the pupil the spirit of science in relation to healthful living.

I have read the book and also used it for reference in my hygiene classes. Such chapter headings as "Beautiful Skin and Hair Reflect Health" are interesting and stimulating. In this chapter the following are considered: (1) The natural desire to be good-looking; (2) structure of the skin; (3) work of the skin; (4) general health affects the skin; (5) pimples and blackheads; (6) freckles; (7) warts; (8) boils; (9) the hair and what it does; (10) care of the scalp; (11) gray hair; (12) baldness; (13) care of the hands and nails. The material is concise, complete, and adapted to the interests of the high-school student. The concluding paragraph of this chapter gives the names of several reference books and a list of questions and interesting things to do in connection with the study of the hair and skin. The many illustrations add to the interest of the reader and help to visualize the points more accurately.

As a health teacher I find this book commendable because it covers all the essential features of hygiene in an interesting and accurate way. I feel that it stimulates the reader to further interest by bringing out the relation of science to health.

M. B. MERCER

Experiments in Health, by J. MACE ANDRESS and MAUD A. BROWN (Ginn and Company).

This manual is a very progressive and valuable work in the teaching of health. Since Galileo dropped the two balls from the tower of Pisa, thus refuting Aristotle's absolute assertion that the heavier ball would drop more rapidly, men have realized that thought is worth while only after it has been tested; in other words scientific thinking supplanted the art of the logician. We have been lax in education in so far as we have taken the path of least resistance and accepted facts from hearsay and texts, especially in the line of health education. The fact that an unclean tooth decays may be undeniably true, but for the average junior-high youngster it means nothing. This manual reports experiments which enables the student to secure proofs. The experiments are graded and tested. They require very little inexpensive apparatus and encourage scientific thinking to the utmost

After a child has completed his experiments he has some fact in hand which is his.

The book is well arranged; *i.e.*, pages are perforated and can be easily torn out for the convenience of the experimenter; they are arranged to expedite recording of results; and a list of chemicals and apparatus needed in the experiments has been compiled.

FRANCES SAMUELSON

The Earth for Sam, by W. MAXWELL REED (Harcourt Brace and Company, pp. xii, 390).

Mr. Reed has put into stimulating and attractive form for young readers the history of the development of life on the earth. The geologic eras are vividly described and illustrated with a wealth of excellent drawings and photographs. The information conveyed is as scientifically accurate as the presentation is vivid. The book has, as the writer of this review knows from direct observation, a strong appeal to children of junior-high-school age.

A. D. W.

Beginning Chemistry, by GUSTAV L. FLETCHER, HERBERT O. SMITH and BENJAMIN HARROW (American Book Company, pp. 476).

This is an excellent introductory text to the study of chemistry, bringing up to date in a comprehensive manner the most recent developments in that science. The whole book is interesting reading and should appeal to high-school boys and girls, since the authors have consciously tried to make use of the scientific background of such students in presenting the principles and facts which underlie the study of chemistry. Such a treatment of subject matter illustrates the psychological arrangement of the material presented.

The reviewer believes the presentation of valence in this book may be more easily comprehended by the beginner since it is first preceded by the theory of radioactivity and chemical change. In the chapter on "The Colloidal Condition of Matter," a difficult topic is presented in an interesting manner.

The chapter on "Organic Chemistry" gives the beginner a clear picture of the composition of food, including proteins, fats, carbohydrates, mineral ash, vitamins, and water, diseases resulting from deficiency in some of these foods, the digestion of foods, and the constituents of a wholesome diet.

Each chapter is followed by a supplementary reading list of current chemistry books and articles, and instead of summaries the authors have raised many pertinent questions to stimulate thought. For interested students who have time, excellent optional questions are given. The entire book is adequately illustrated.

HELEN CIENKI

Educational Biology, by W. L. EIKENBERRY and R. A. WALDRON (Ginn and Company, pp. 549).

This is a textbook intended for freshmen in teachers colleges who have or have not had a course in biology in high school. It treats the subject from the educational point of view, and is intended as a stepping stone to other closely related courses such as hygiene, nature study, physical education, psychology, educational sociology, etc. It treats the strictly biological subject matter from the physiological rather than from the anatomical viewpoint.

The language of the book is not overburdened with technical terms; the vocabulary is within the range of students. The lists at the end of divisions will aid the students in systematic classifications and technical terminology if they wish to use them.

The book is so organized that it may be used with or without a laboratory. The questions and problems at the end of the chapters and the extensive references are suggestive and helpful. Students working through Part V will not need the biology part of a psychology course. In the same way Part VI is basic for educational sociology. The book is worthy of very careful consideration on the part of those working in the field for which the text is intended.

LEWIS ELHUFF

Introduction to Science, by CALDWELL and CURTIS (Ginn and Company, pp. xvi, 658, xxxviii).

A comprehensive and stimulating treatment of the many ways in which the principles of science touch the daily lives of all of us. The content was selected on the basis of a synthesis of several investigations. The topics are thus given added validity. The vocabulary is confined almost entirely to the 5,000 most frequently used words in the English language as determined by Thorndike's investigations. At the end of the chapters new-type tests of various kinds are presented in such a way that they can be used as guides for directed study or as exercises in review. The book is planned for a full year of general science for the eighth or ninth year of junior high school.

A. D. W

OTHERS SAY

FLOYD E. HARSHMAN

Miss Olive Dillon, dramatic coach in the Evander Childs High School, New York City, published an article, "Why Not a Theater in Every High School?" This article appeared in *School Executives Magazine* for December 1929.

Miss Dillon believes that it is just as important to have a school theater as it is to have school shops and other vocational units. The matter of acquiring appreciation for the things of the stage is one of education. Quoting from the article: "The theater should never be distinct from the school's daily life. The thing that is constantly before us impresses itself on our consciousness. Men found it cheaper to invest in reels and a projector than to pay actors' salaries, and they made enough money to set up a motion-picture palace on every corner.... if we who love the theater, and know its life-giving force, want future audiences to flock to it, then right now is the time to direct the interests and energies of all those in the high school into the theater by having a working theater in every school."

THE OFFICE OF STATE SUPERINTENDENT IN PENNSYLVANIA IS NOT DOMINATED BY POLITICS

In answering the criticism by Dr. James C. Bay of Easton, Pa., who asserted that such was the case, Dr. John A. H. Keith, State superintendent, made the above statement. We quote from the *Pittsburgh Press*.

"In my three years as superintendent of instruction no political pressure has been put upon me, and I haven't found it as bad as painted.

"Reorganization of the State-school system has been a subject of thought and consideration for more than twenty years. It is not new. It has always been rejected.

"Pennsylvania has tried to keep education out of politics. It has succeded more than most States. The constitution makes my appointment for four years. I can not be put out of office at the governor's pleasure.

"Dr. Bay's attack is unjustified, but he has made no assault on me. He is a friend of mine. He merely attacked the system which makes my office the type it is.

"Dr. Bay proposes to make the schools entirely academic. That may sound well, but it is not. We should all retain our ideals, but must recognize the necessity of having contact with more than the academic."

HIGH POINTS IN ADDRESSES DELIVERED AT THE ATLANTIC CITY MEETING OF THE NATIONAL EDUCATION ASSOCIATION OF INTEREST TO SECONDARY EDUCATION

Quoted from *The Gist*, American Education Press.

New Theory Needed, Jesse H. Newlon, Lincoln School, Teachers College

"The most casual examination of our secondary school will convince any one that mechanization of learning, a lack of integration of its educational processes, is one of its salient characteristics.

"Six conditions are essential to the development of an integrated and socially effective secondary curriculum:

"1. The entire period of secondary education should be treated as a unit. This would mean the inclusion of the junior college as a permanent feature.

"2. Each administrative unit should embrace as many grades as possible. The short unit of two or three grades has proved unsatisfactory.

"3. Every barrier that prevents the adaptation of a program of education to the needs of the individual should be torn away. No pupil should ever be compelled to study a subject merely to meet an arbitrary requirement.

"4. A thoroughgoing reconstruction of the secondary-school curriculum with a view to adapting it to the conditions of modern life is fundamental to integration.

"5. A resynthesis of subject matter for purposes of teaching is one of the greatest needs.

"6. A more effective program of guidance is essential."

Function of Junior High School, Philip W. L. Cox, New York University

"The junior high school expresses a changing conception of education. This new type of school is characterized by tolerant, friendly, and spontaneous relationships among pupils, teachers, and parents. It becomes increasingly clear, however, that the conventional high-school subjects are not successful in challenging many capable adolescents. These youths either can not or will not master the knowledges and skills, nor will they even complete the assigned lesson preparations. For the academic high-school teacher the times are sadly out of joint.

"To dance, to know the current magazines and books and plays, to help mother with the housekeeping, to select and alter their clothes, to take one's share in church or Sunday-school activities, to be a good Scout or a member of the Girls Reserve, to keep up one's music lessons and practice, to study geometry, to share one's fathers interests, to earn and save money towards the expenses of

college education, to give reasonable attention to one's friends of both sexes, to take one's part in the school's dramatic and social and political life, to participate in athletics, to conserve one's health, to keep up one's correspondence, to play a respectable game of bridge—such a list could be continued almost endlessly. To us schoolmasters these activities may not all seem of equal importance; some of them we may deprecate entirely. But to some social groups and individuals whose judgments the adolescent respects, every one of them seems to be of outstanding importance.

"To the degree that the junior high school can so convincingly transfigure the school processes that abundant living and integrated personality through some form of creative expression may be understood and appreciated by senior-high-school teachers and by community leaders, it will make its positive contribution to our changing secondary schools."

Modern Business Looks At Secondary Education, Frank P. Jewett, Vice President of the American Telephone and Telegraph Company

"Farsighted commercial executives believe in an education that fits youths to meet the pattern of a changing world."

Warning that education, to be useful, must avoid superficiality, Mr. Jewett said, "business has no use for detailed technical training acquired at the expense of basic mental training." He urged that "training should not deprive the child of capacity for hard intellectual work."

"Business itself is quite competent in the main to provide the details of training in the technique of its operations. True, it may be of some help to us in some directions to have boys and girls enter our ranks with a rudimentary knowledge of certain kinds of technique.

"Further, we do not quarrel with you concerning education in matters of this kind if you believe that the things you do have a sound basis. We do quarrel with you if you carry this kind of training too far in amount and diversity and so deprive your product of the capacity to advance in after life for lack of suitable training of mind which you of the secondary school alone have the opportunity to give.

"As a group, we of business are finding now, if we did not know it before, that the man or woman who is a good citizen, with capacity through training to live a happy life without complete dependence on artificial stimulation, and to approach every problem thoughtfully, is the finest asset which any organization can have. We have learned that those who are trivial and incapable of thoughtful consideration in their general lives are trivial and unthoughtful in their industrial environment, and so are a drag not only on their own progress but on the organization of which they are a part."

Organising Supervision, Charles H. Lake, Assistant Superintendent, Cleveland, Ohio

"Rarely, if ever, do we discover a really good school in which the principal is not interested in supervision. The primary responsibility for supervision in a city system must be placed upon the principal, and the work in our schools will not be as effective as it should be until we place the responsibility for securing good work in the schools—elementary as well as secondary—with the principals, and they accept it.

"It is easy for the principal to accept the theory of supervision, but it is quite difficult for him to accept it as the most important of his responsibilities."

Fallacies in Objectives, John R. Patterson, Supervising Principal, Roselle, N. J.

"Two propositions in the main give direction to present educational effort. These are:

1. Education must be conceived in terms of social outcomes.

2. Learning is effective proportionally to the directness of the experiencing; *i.e.*, informal education is best."

After discussing these major theses the speaker summarized by partially answering the query, "What then is the prudent course for education?" He used four statements:

"1. Education in both method and content can legitimately be largely social. Yet it should not be wholly social. It must take cognizance of the needs of *man as man*. A view altogether social leaves out too much of the nature of man.

"2. Initial learning should be acquired through informal education.

"3. As the individual moves from intellectual immaturity towards intellectual maturity an increasing volume of learning can most economically be had through formal education.

"4. For those individuals and groups of apparently permanent immatureness intellectually, learning throughout the whole of life must remain largely on the level of direct experiencing."

Wanted—A Philosophy of Education, Thomas H. Briggs, Teachers College, Columbia University

In speaking of the urgent need for a philosophy of education to guide every level of public education, and for a statement of objectives from the elementary school to the highest schools, Dr. Briggs said in part, "There is only one sound justification for the provision of free education at public expense, and this is that it may make each individual better able and better disposed to contribute to the betterment of the supporting society.

"When one examines the curriculum of most schools or the major part of the curricula of all, especially of those on the secondary level, he must be convinced that education is not, nor is it intended to be, taken seriously. If it were, its program would obviously manifest its intention of affecting life and affecting it materially for better living—culturally, socially, or vocationally. Let us freely admit and justifiably boast that there have been great improvements in this matter, that there is much in the curriculum of even the poorest school contributing directly and effectively to the betterment of life; but when we have done this we find that there is a residue so large and so manifestly useless to pupils for whom it is administered as to prove the contention that, as a people, we do not realize the importance of education."

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2. The samples used in the Scale are actual samples of child writing, without retracing or altering in any way.

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